

F O U R T H E D I T I O N

Mahajan & Gupta

TEXTBOOK OF

PREVENTIVE
AND SOCIAL
MEDICINE

Revised by

RABINDRA NATH ROY
INDRANIL SAHA

Mahajan & Gupta

Textbook of
Preventive and Social Medicine

In their Esteemed Opinion....

“ I congratulate you for your bold and strenuous effort in bringing out the Textbook of Preventive and Social Medicine for medical students in India. This book would definitely become popular very soon in India.”

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— **Dr Abdul Rauf**, Professor and Head, Department of Social and
Preventive Medicine, Government Medical College, **Srinagar, Jammu and Kashmir, India**

Mahajan & Gupta Textbook of Preventive and Social Medicine

Fourth Edition

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Dedicated to

*My dear wife
(Late) Dr Manju Gupta
(27-1-1948—13-6-1996)
without whose
inspiration and sacrifice
this book would not have been possible*

MC Gupta

Preface to the Fourth Edition

The last few years have witnessed a rapid progress in the field of Community Medicine. There was a felt need for publication of an updated fourth edition of this book after a gap of couple of years. Many new concepts have arisen and much more modifications have been incorporated over the past strategies. We think this edition will also meet the expectations of the medical and nursing students, as well as the students of Public Health, teachers of Community Medicine and the program implementers of health services.

Almost all the chapters have been thoroughly revised and updated; notably among those are epidemiology, communicable and noncommunicable diseases, MCH and family planning, management, demography and vital statistics, disaster, biomedical waste management, food and nutrition, immunization, geriatrics, communication, etc. National Health Programs have also been thoroughly revised and updated. New data have been incorporated, wherever applicable. Latest SRS and census data have also been included. Various domains that are of importance, both in theory, practical and viva of MBBS examination have been highlighted with examples and justification. Many postgraduate study materials have also been incorporated with references for further reading. Various flow charts, diagrams and pictures have been introduced for clarity of understanding. Students will be benefited for their preparation in answering MCQ for their Postgraduate Entrance Examination.

It is our earnest hope that fourth edition of this textbook will help the MBBS, Postgraduate aspirants, Postgraduate students and the students of other public health disciplines. We will be grateful to the students and the teachers for their valuable feedback, comments and constructive criticism. We will acknowledge and will try our best to address those issues in the subsequent editions.

Rabindra Nath Roy
Indranil Saha

Preface to the First Edition

Preventive and social medicine is one of the most important subjects in the curriculum of a medical student. Unlike other subjects, preventive and social medicine, community medicine and community health are the concern not only of those specializing in these fields but of all others in the medical profession, including those engaged in active clinical care as well as the health administrators. As a matter of fact, the subject is of serious concern to all interested in human health and welfare, whether in the medical profession or not. The present book is patterned on the earlier book *Preventive and Social Medicine in India* by Professor BK Mahajan, published in 1972. However, the marked developments in the subject during the last 20 years have necessitated extensive changes and additions. Hence, this volume is presented as a new book in its first edition. The entire approach is epidemiological and the subject matter is presented in a linked and continuous manner. The language and style are simple, and attractive with emphasis on practical aspects which may be of utility not only to PHC medical officers and health administrators but even to general practitioners.

The whole book is divided into four parts. The first part deals with the general aspects of preventive and social medicine and its scope. The second part, comprising two-thirds of the book, is built around the epidemiological triad. The third part deals with demography, vital statistics and biostatistics. The fourth part is devoted to health care of different groups, and includes detailed discussion of primary health care, health policy and the relation between health and development. The above division is objective and purposeful. It makes the reader familiar with the essential course content of community medicine, inculcates in him the epidemiological approach to health and disease, and prepares him to practise family medicine as a family physician. A chapter on general practice has been added for this purpose.

Though the book is primarily written for the undergraduate students, it would be of use to the postgraduate students as well. The number of references has been kept to a minimum. Only those references have been included which substantiate a controversial or less widely-known point, or which relate to recent work or review.

Inter-relation between health and development, health manpower planning, communicable disease epidemiology in natural disasters, mental health program and the program for control of acute respiratory infections have been discussed in detail. The national ICDS program has been given adequate coverage. Care has been taken to include practical aspects in relation to diagnosis and management of leprosy, which may have to be tackled by many PHC medical officers and general physicians. Special attention has been paid to the chapters on social environment, host factors and health, noncommunicable diseases, food and nutrition, demography and vital statistics, health policy, planning management and administration, primary health care, health education, information and communication, maternity and child health, school health, geriatrics, mental health and health service through general practitioners so as to present the concerned topic in a most up-to-date and easily comprehensible manner.

Some sections, such as those relating to water supply and disposal of wastes, could have been reduced further by omitting certain details; the latter have been retained in view of the requirement of public health administrators. The existing curricula of various universities, as also the suggestions from eminent professors, have been given due consideration while preparing this book. We shall feel amply rewarded if this book is found useful for students, teachers, public health administrators and PHC medical officers.

We are grateful to a large number of colleagues in different parts of India, who spared their valuable time and effort to go through the manuscript, offered constructive suggestions and incorporated appropriate changes wherever necessary. These include Professor YL Vasudeva and Professor Sunder Lal (Rohtak), Professor RD Bansal and Professor SC Chawla (LHMC, Delhi), Professor OP Aggarwal (UCMS, Delhi), Professor G Anjaneyulu (Hyderabad), Dr GS Meena (MAMC, Delhi), Professor IC Verma, Dr Bir Singh and Dr Ravi Gupta (AIIMS, Delhi), Dr GVS Murthy and Dr K Madhavani (Wardha), Dr LN Balaji (UNICEF) and Professor KK Wadhera (CMC, Ludhiana). Professor Bansal, Professor Anjaneyulu and Professor Wadhera, in particular, took special pains to

go through the entire manuscript critically at various stages of preparation. We owe special gratitude to Professor G Anjaneyulu, for writing a foreword to the first edition for the book after going through the entire manuscript.

We are thankful to the American Public Health Association, Washington, and the Institute of Health and Nutrition, Delhi, India for permission to reproduce certain portions of the text from their publications. Reference to original source has been made wherever this has been done. We must thank to M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, India, who have done a marvellous job in record time, in spite of delay from our side. We must also acknowledge the contribution of our typists Shri Rameshwar Dayal and Shri Murli Manohar, whose excellent typing skills greatly reduced the drudgery associated with drafting and redrafting of a manuscript. Lastly, we must express our heartfelt thanks and indebtedness to our wives who silently, and sometimes not so silently, suffered—their husbands continuously lost in books, papers and proofs in utter disregard of their domestic responsibilities.

MC Gupta
(Late) BK Mahajan

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We would like to thank the people without whom this book would not have been possible, they are our colleagues, students and our family. We are thankful to the Almighty for the ability, circumstances and health that were needed to write the book. Last but not the least both the editors thankful to M/s Jaypee Brothers Medical Publishers (P) Ltd, Kolkata and New Delhi, India to give this special opportunity to update and revise *Mahajan & Gupta Textbook of Preventive and Social Medicine*.

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Evolution of Preventive and Social Medicine

Preventive and Social Medicine is comparatively a newcomer among the academic disciplines of medicine. Previously it was taught to medical students as hygiene and public health. This name was later changed to preventive and social medicine when it was realized that the subject encompassed much more than merely the principles of hygiene and sanitation and public health engineering. The name preventive and social medicine emphasizes the role of: (a) disease prevention in general through immunization, adequate nutrition, etc. in addition to the routine hygiene measures, and (b) social factors in health and disease.

The name preventive and social medicine has gained wide acceptance in the past twenty-five years or so because of its broader and more comprehensive outlook on medicine, integrating both prevention and cure. Today, it implies a system of total health care delivery to individuals, families and communities at the clinic, in the hospital and in the community itself.

Historical Background

During last 150 years, there have been two important “revolutions”. The *industrial revolution* in 1830 was associated with the discovery of steam power and led to rapid industrializations, resulting in concentration of wealth in the cities and, consequently, migration from rural to urban areas. The net result was that on the one hand the villages were neglected and, on the other, the towns and cities witnessed rapid haphazard expansion, often leading to creation of urban slums. These changes brought in their wake and more complex health problems in rural as well as urban areas which ultimately led to development of the concept of public health. The *social revolution* occurred around 1940, during the Second World War. The social revolution brought into force the concept of ‘Welfare State’. It envisaged the total well being of man, paying major attention to the forgotten majority living in the villages. It was aimed at fighting the three enemies of man—poverty, ignorance and ill-health on a common platform. This followed the realization that health was not possible without

improvement in economic condition or education and vice versa.

Among the developing countries, India gave a lead for bringing about the total well being of rural people by instituting the remarkable Community Development Program (1951). For intensive all-round development, the country was divided into Community Development Blocks in which ill-health was to be fought through the agency of primary health centers as recommended by the Bhore Committee. It may be mentioned that the concept of public health was fairly well developed in ancient Indian. Adequate proof of community health measures adopted during Harappa Civilization as far as 5000 years ago has been found in the old excavations at Mohenjo-Daro and at Lothal near Ahmedabad in the form of soakpits, cesspools and underground drainage.

Public Health, Preventive Medicine, Social Medicine and Community Medicine

Traditionally, a young man planning to enter the medical college has in mind the picture of a patient in agony, in relieving whose suffering by medicines he considers himself to be amply rewarded. He always thinks of alleviating the suffering of a patient but rarely about the prevention of such suffering at the level of the individual patient, his family or his community. No doubt he has to play a very important role in meeting the curative needs of society but that is not all. The community in the past has felt satisfied with that curative role. But now the developing society, in India and elsewhere, expects much more from the doctor, and the people are gradually becoming more and more conscious of their health needs. These varied expectations are reflected in the fact that the subject has been practised in the past under different names as discussed below.

Public Health

It was defined by Winslow (1851) as the science and art of preventing disease, prolonging life and promoting

health and efficiency through organized community measures such as control of infection, sanitation, health education, health services and legislation, etc. Public Health developed in England around the middle of the nineteenth century. Edwin Chadwick, a pleader, the then Secretary of Poor Law Board (constituted under Poor Law Act passed in 1834) championed and cause of community health and the first Public Health Act was passed in 1848. This signified the *birth of public health*.

Public Health in India followed the English pattern but the progress was extremely slow during the British regime. It started after 1858 when a Royal Commission was sent to find the reasons for heavy morbidity and mortality among European troops in India due to malaria and some other preventable diseases. The Public Health Departments started as vaccination departments and later as Sanitation Departments at the Center as well as in the Provinces around 1864. There was a long tussle whether the Sanitation or Public Health Department should be responsible directly to the Government or to the Surgeon General-in-Charge of Hospitals and Medical Education. It took almost 40 years for the British Government to decide in 1904 that Public Health Departments should function separately. The designations of Sanitary Commissioner and Assistant Sanitary Commissioner were changed to those of Director and Assistant Director of Public Health. Thus curative and preventive departments worked separately as Medical and Public Health Departments. This continued in India even after independence for some time, though the idea of integration started at the beginning of the Second World War. A recommendation to this effect was made by the Bhore Committee in 1946.

Preventive Medicine

Preventive medicine developed as a specialty only after Louis Pasteur propagated in 1873 the germ theory of disease followed by discovery of causative agents of typhoid, pneumonia, tuberculosis, cholera and diphtheria within the next decade. It gained further impetus during subsequent years from the following developments:

- Development of several specific disease preventive measures before the turn of the century (antirabies treatment, cholera vaccine, diphtheria antitoxin and antityphoid vaccine).
- Discovery and development of antiseptics and disinfectants.
- Discovery of modes of transmission of diseases caused by germs. Transmission of malaria, yellow fever and sleeping sickness had been elucidated before the turn of the century.

It may be said in retrospect that when public health gained roots with the passage of the Public Health Act, the emphasis was on environmental sanitation alone.

With the advent of the specialty of preventive medicine, emphasis was also given to prevention of diseases. These included not only infective diseases but also others such as nutritional deficiency diseases.

Social Medicine

It is defined as the study of the man as a social being in his total environment. It is concerned with the health of groups of individuals as well as individuals within groups. The term social medicine gained currency in Europe around 1940.

In 1949, a separate department of Social Medicine was started at Oxford by Professor Ryle. The concept of social medicine is based upon realization of the following facts:

- Suffering of man is not due to pathogens alone. It can be partly considered to be due to social causes (social etiology).
- The consequences of disease are not only physical (pathological alterations due to pathogens) but also social (social pathology).
- Comprehensive therapeutics has to include social remedies in addition to medical care (social medicine).
- Social services are often needed along with medical care services.

Interest in social medicine began to decline with the development of epidemiology. The Royal Commission on Medical Education substituted in 1968 the term social medicine by community medicine in its report (Todd Report).

Preventive and Social Medicine

As clarified above, preventive medicine and social medicine cover different areas, though both are concerned with health of the people. This is why the combined name Preventive and Social Medicine was suggested to provide a holistic approach to health of the people. This name was preferred to the earlier name public health because the former had come to be visualized as a discipline dealing mainly with sanitation, hygiene and vaccination. However, the term public health has now once again become fashionable in England.¹

Community Medicine

It has been defined as “The field concerned with the study of health and disease in the population of a defined community or group. Its goal is to identify the health problems and needs of defined populations (community diagnosis) and to plan, implement and evaluate the extent to which health measures effectively meet these needs”.² Broadly, one could state that community medicine, while encompassing the broad

scope of preventive and social medicine, lays special emphasis on providing primary health care.

It may be remembered that five of the eight components of primary health care, as described later in Chapter 28, are related to clinical activities. The modern day message is that the discipline variously labelled in the past as public health or preventive and social medicine cannot be divorced from health care, including clinical care of the community. It is in recognition of this wider role that the Medical Council of India has recently decided to label the discipline as Community Medicine in place of Preventive and Social Medicine. In a recent case decided by the Supreme Court of India the issue was whether the Department of Preventive and Social Medicine in a Medical College is a Clinical or Paraclinical Department. It was held that it is a Clinical Department.

Some milestones and history of public health:

- Father of Medicine: Hippocrates (Greatest physician in Greek medicine)
- Father of Indian Medicine: Charak
- Concept of bare foot doctors and acupuncture: Chinese medicine
- Yang and Yin principle: Chinese medicine
- Father of surgery: Ambroise Pare

- Father of Indian surgery: Sushruta
- First distinguished epidemiologist: Sydenham
- Great sanitary awakening: Edwin Chadwick
- Father of public health: Cholera
- Deprofessionalization of medicine: Primary health care
- First vaccine developed: Smallpox
- Term vaccination: Edward Jenner
- Term vaccine: Louis Pasteur
- Citrus fruits in prevention of scurvy: James Lind
- John Snow: Cholera
- William Budd: Typhoid
- Robert Koch: Anthrax
- Germ theory of disease: Louis Pasteur
- Multi-factorial causation of disease: Pattenkoffer
- Social medicine: Virchow
- Growth chart: First designed by David Morley
- First country to socialize medicine completely: Russia
- First country to introduce compulsory sickness insurance: Germany

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In this chapter, we will first consider why should a medical student study community medicine. Then we shall discuss the basic concepts related to health, disease and prevention.

Why to Study Community Medicine?

Before the student starts studying community medicine, he must have motivation to study it. Motivation can follow only when he can get a clear answer to the question—“I want to become a doctor, treat patients and reduce their suffering. Why should I study community medicine at all”? Let us try to answer this question. Some of the reasons why a medical student should take interest in community medicine and study it seriously are given below:

Treatment of patients: A doctor’s aim should be to treat a patient, not to treat a disease. For example, a patient may present to a doctor with malnutrition, tuberculosis or diarrhea. The doctor’s responsibility does not end with prescribing nutritious diet, antitubercular drugs or fluid therapy. If he does so, he would merely be treating a disease episode, not the patient. In order to understand this better, let us imagine three scenarios.

1. Imagine yourself sitting in a busy pediatric outpatient clinic. A mother has just brought in her fifth child, a boy aged two years. He has sunken eyes, wizened appearance, wasted muscles, pot belly, bow legs and a skin and bones appearance. You chide the mother for her “uncaring attitude” and ignorance and scold her for coming so late. You prescribe a dose of vitamin A and an antihelminthic, give cursory advice on nutrition and send her away. The case sheet is closed and you call out the next patient. You learn after 6 months that the child died some time ago.
2. Imagine a different scenario. This time you are sitting in a busy medical OPD. A 30-year-old mother of three children presents with cough of three months duration, loss of weight, hemoptysis and continuous fever. You put your stethoscope to her chest and before you have time to blink your eyes, the diagnosis stares you in the face. You prescribe antitubercular drugs, record the notes and send her to the dispensary, expecting the staff there to give her

detailed information about the medication. When the child and woman come back a few months later in a worse condition with the same recurrent problem, your conscience is pricked. Now it becomes obvious that there is something wrong with the system. Medical care itself is not sufficient. Individual illness is itself symptomatic of a wider social malady afflicting the individual, the family and the community.

3. Let us now look at the situation existing in many of our remote, ill connected villages. In a small hamlet cut off from modern civilization, a male infant aged eight months, the only child of his parents and the fond hope of his grandparents, suffers from diarrhea. There are no trained health functionaries in the village. The nearest hospital is 35 kilometers away. The parents, being landless laborers, have no means to reach the nearest hospital. Within 12 hours the child’s condition becomes critical. The mother gives the child some herbal decoctions as advised by the local *dai*. The result: no improvement. Within another six hours the child takes his last breath. With all its technological sophistication, does modern medicine have an answer for this unwarranted death? Unless technological breakthroughs are supplemented by “social revolution” to communicate information effectively to the thousands who need them, they are of no avail. Cheap interventions like ORS can become meaningful only if people are armed with knowledge about them and put this knowledge into practice whenever needed. This is an area where community medicine practice can help.

It is clear from the above three realistic examples that for treating a patient in the real sense of the word, a doctor has to know more than clinical medicine; he has to know the preventive and social aspects of disease.

Social equity: Resources for health care are limited. These resources must be equitably distributed among the people. For the cost of one big hospital, it is possible to create 50 small accessible health posts in the community. For one patient needing coronary bypass surgery, there are thousands in need of treatment for diarrhea, skin disease, respiratory infection, fever and hepatitis, etc. Who should get priority when it comes to providing free medical care through the country’s health system—the bureaucrat or politician who needs sophisticated cardiac care or the

thousands of unimmunized, malnourished children and pregnant women who have no access to simple technology like growth monitoring, ORS, immunization, antenatal care, etc.? Only a thorough knowledge of principles of community medicine can provide answers to such dilemmas.

Health services planning: The needs of the many should take precedence over those of the few. This issue becomes even more complex and critical by our knowledge that those who are in the greatest need of health care may not even know about their need; even if they do, they may not be able to seek health care. How can we come to know what the population's health needs are? Do we even know whether health is a priority for most people? And what are the reasons which prevent them from seeking help at designated health facilities? Such questions must be answered before health services are planned for people. Experience of community medicine can considerably help in this regard.

Doctor's responsibility: At the center of a moralistic debate is the question of a doctor's responsibility. To whom is a doctor responsible? Only to those who come to the clinic or also to those who need his services but cannot come to the clinic? Where does the responsibility end? We must realize that the health sector in a country cannot be divorced from the country's economic or social fabric. Sitting in an ivory tower may isolate us but cannot insulate us from reality—the situation existing in the country. Thus modern medicine has to extend itself outside the confines of the four walls of a hospital and seek solutions at an affordable cost. It is not enough to have theoretical knowledge and the pharmaceutical prescriptions to promote health and manage disease in the community. We must also necessarily have a system of health care delivery that can implement the feasible solutions and make them available to as many as possible at a cost that the country and the community can afford. Community medicine strives to provide the appropriate solutions in this regard. Examples are the national programs for malaria, filaria, tuberculosis, AIDS, iodine deficiency diseases, diarrheal disease, anemia, vitamin A deficiency, etc.

Patient's queries: Many a time a doctor is confronted with the question—"Doctor, what is the chance that I may get carcinoma of the lung since I smoke 20 cigarettes a day"? or, "Doctor, I am suffering from tuberculosis. Can I breastfeed my child"? Answers to these questions are only possible if one is familiar with the natural history of disease, its etiology and the myriad risk factors and their interactions. These are addressed by community medicine.

Interaction with patients: Even doctors who have decided to set up private practice can benefit from the

discipline of community medicine. Knowledge of community dynamics, community skills and cultural factors related to health improves the doctor-patient interaction and directly leads to increased patient confidence and improved compliance.

Health team leadership: Health practice is a team effort and the doctor is the team leader. The varied knowledge encompassed within the ambit of community medicine will make the doctor a strong team leader and an able health administrator.

Concepts of Health

Health is one of the most difficult terms to define. Health can mean different things to different people. To some it may mean freedom from any sickness or disease while to some it may mean harmonious functioning of all body systems. It may be construed as a feeling of "wholeness" and a happy frame of mind. At the center of the debate is whether health denotes a positive quality or whether it should be understood or defined in terms of the absence of a negative quality, i.e. freedom from disease. Modern medicine or modern medical practice tends to view health as simply the state of absence of all known diseases. Doctors are too busy fighting disease to be unduly bothered about health. Even when they are caring for well babies, the parameter chosen to so define a baby is in terms of absence of congenital abnormalities or postnatal deleterious effects. When doctors spend time to screen adult populations for carcinoma of the cervix, hypertension or the like, their focus of interest is on absence of these morbid conditions. Thus the emphasis in modern medicine has been on freedom from disease. If this be the yardstick, then what does one strive for? If the best is to be the goal, health necessarily needs to be defined in a positive fashion.

The WHO (1948) has attempted to construct a positive definition of Health and has described Health as "a state of complete physical, mental and social well-being and not merely an absence of disease or infirmity."¹ Later on (1978), it has been added as to lead a "socially and economically productive life". This is an all-encompassing definition and clearly places health on a higher pedestal in comparison to disease. This definition, however, refers to an ideal state which one strives to achieve, though one may not be able to do so. There has been criticism that using such a yardstick, very few people would be categorized as healthy since almost everyone would have some grade of ill health or abnormality, may be in a clinical, subclinical, pathological or biochemical sense. It is perhaps best to talk of the WHO ideal of positive health as the top of the ladder while other categories of health status may occupy lower rungs. A diseased state may be categorized at the lowest rung of the ladder.

Such a categorization of health is akin to a spectrum, with positive health at one end and a diseased state at the other end. This conceptualization permits one to talk of health as a dynamic state capable of moving up or down the ladder, rather than a static state in equilibrium. This is appropriate because the health status cannot remain constant for an individual, family, community or country over a period of time.

Let us now look at the components of the WHO definition, i.e. physical, social and mental well-being.

Physical well-being is most easily understood by all of us. Physical health relates to the anatomical, physiological and biochemical functioning of the human body. Thus the attributes of physical health denote normalcy of the body structure and organs and their proper functioning. One should remember that a “normal state” in medicine is based on the law of averages and the extent of deviation from the average or the mean. Thus the normal state for a European may be different as compared to the Asians. If the deviation is excessive, it may constitute an abnormal situation. The selection of the limits of “normalcy”, even in statistical terms such as 2 standard deviations from the mean, is an arbitrary cut off point. Thus the line dividing normal and abnormal is very thin near the preselected limits. It should also be remembered that these limits of normalcy can change over time or generations.

Various modes of assessment of physical health are available, e.g. height, weight, muscle mass, head circumference, serum estimations, physiological tests of functioning such as forced expiratory volume, etc. but all of them define normalcy in statistical terms and in relation to the risk of developing a particular disease, e.g. elevated serum cholesterol related to cardiac disease, etc.

Social well-being is more difficult to define. In its simplest connotation, social health means that level of health which enables a person to live in harmony with his surroundings. Man is, after all, a social animal. He both learns from and contributes to society. Health is both a product of and a determinant of social values. The cultural and ethnic background, the traditions and mores, the economic and literacy levels, the needs and perceptions are all important in the consideration of social health. To measure social health is much more difficult but social scientists have tried to make such measurements more objective. Thus social health can be measured by attitude scales, socioeconomic status, level of literacy, employment status, etc. All these measures, however, are indirect measures of social health.

Mental well-being is perhaps the most abstract component to describe. Recent developments in psychiatry and psychology have helped in defining features of mental health in a better fashion. A positive mental health state indicates that the individual enjoys his routine; there are no undue conflicts, nor frequent bouts of depression or elevation of mood, he has harmonious relations within the

family and community spheres and is not unduly aggressive. However, there may be transient digression into the zone of the abnormal, especially under stress or duress. Tests have been developed in recent decades which indicate the mental health status of individuals. These include tests for IQ, personality tests, thematic appreciation tests and projective techniques.

Spiritual health may be construed as a component of mental health. In societies like the Indian society, religion has played an important role in shaping the cultural ethos. Many individuals strongly believe in the supernatural. In such situations a positive mental health embraces spiritual health. Spiritual health may help to resolve both internal as well as external conflicts.

Many a time doctors are approached by patients with vague complaints like generalized aches, disinterest in work, easy fatigability, etc. However, no abnormality is detected on examination. Are these individuals to be classified as “healthy” or in poor health? Though they may not be actually diseased, they may also not be labelled as healthy because they perceive themselves as not being in good health, and their mental health is thus compromised. Health, therefore, is not a constant entity but a relative state. It is relative to time as well as to individuals. The threshold of pain is not the same in any two individuals and so their perception of a healthy state is obviously different. Therefore health appears to be a matter of degree. Almost every individual’s state of health can potentially improve.²

Determinants of Health

What is it that results in good health, optimum health or positive health? It is certain that the health status cannot be the result of one particular activity. Many influences have a bearing on health. The influences which affect health and well-being are called determinants of health. Some of these determinants are:

Genetic configuration: The health of a population or an individual is greatly dependent upon the genetic constitution of populations. These genetic factors may be overshadowed by other factors but still play a substantial role. Genetic traits related to certain enzymes (e.g. G-6-PD deficiency) or HLA markers (e.g. diabetes) can lead to a change in health status.

Level of development: Economic and social development helps to improve health status. Such development potentially removes many deleterious factors in the external environment of man. However, affluence can also bring many problems in its wake. These are related to the lifestyle adopted by the affluent.

Lifestyle: Contemporary Western society is nearing the pinnacle of socioeconomic development. This has led to improved health facilities and increased health awareness. With improved literacy and better

employment opportunities now available, many of the health problems confronting the less developed countries have been erased. However, sedentary lifestyles an overambitious outlook, excessively aggressive competition, lack of regular exercise, excessive consumption of alcoholic beverages and smoking, etc. have brought noncommunicable diseases like diabetes, hypertension, myocardial infarction, etc. to the forefront. Similarly, mental health has also been compromised. Efforts are now under way to tackle development related problems in the West. An example is the “sin taxes” imposed by the US government in April 1993, markedly raising the prices of alcohol and cigarettes, aimed at reducing their consumption.

Environment: The physical, social and biological environment of man is a very important determinant of health. Poor environmental sanitation, inadequate safe drinking water, excessive levels of atmospheric pollution, etc. are important determinants in the physical environment affecting health. The socioeconomic status, employment potential, harmonious marital relationships, positive employer-employee relationship, etc. are all important factors in man’s social environment. The biological environment is composed of disease bearing arthropods, insects, domestic and milch animals, etc. All the members of the animal kingdom can compromise health status of man.

Health infrastructure: Accessible and acceptable health facilities have a direct bearing on health status. If primary health care facilities are available in the vicinity and such facilities are utilized by the population, the health of individuals and communities is bound to improve.

Indicators of Health

An index is an objective measure of an existing situation. Indices are generally defined as relative numbers expressing the value of a certain quantity as compared with another.³ In relation to health trends, the term *indicator* is to be preferred to *index* as indices are much more precise.⁴ More recently it has been suggested that a health index is better considered as an amalgamation of health indicators.⁵ Indicators are variables which help to measure changes. They are most often resorted to when a direct measure of the change is not possible. As a matter of fact, health being a holistic concept, health change cannot be measured in specified units—it can only be reflected by health indicators.

Characteristics of an Indicator

An ideal indicator should be:

Valid: The degree to which the measurement corresponds to the true state of affairs is called validity. In other words, does the indicator actually measure what it purports to measure?

Precise: Reliability, reproducibility and repeatability are synonymous with precision. They reflect the extent to which repeated measurements of a stable phenomenon are in agreement. The indicator should give the same results if used by different individuals and in different places. Thus precision ensures objectivity.

Sensitive: The indicator should be able to reflect even small changes in health status. For example, the infant mortality rate is a sensitive indicator of the health status and the level of living of a population. Similarly maternal mortality rate is a sensitive indicator of the provision of obstetric services.

Specific: The indicator should reflect changes only in the situation concerned. For example, enrolment in primary school is specific to measurement of literacy.

Why are health indicators needed? *The uses of Health Indicators* are as follows:

- They reflect changes in the health profile over a specified time span.
- They enable delimitation of backward and priority areas in a country.
- They permit international comparison.
- They allow evaluation of health services and specific interventions.
- They help to diagnose community needs and perceptions.
- They are helpful to program planners and health administrators for charting out progress.
- They allow projections for the future.

Types of Indicators

Indicators can be categorized as vital and behavioral.

VITAL INDICATORS

These encompass:

Mortality indicators: Crude death rate; infant mortality rate; maternal mortality rate; perinatal mortality rate, etc.

Morbidity indicators: Incidence and prevalence of infectious disease. An example of incidence indicator is the number of new cases of pulmonary tuberculosis in a given year in a defined population.

Disability indicators: These play a supportive role to other vital indicators. These include sickness absenteeism rates; paralytic poliomyelitis rate; blindness prevalence rate, etc.

Service indicators: These indicators reflect the provision of health facilities. Examples are proportion of population served by PHC/subcenters; doctor population ratio; proportion of population having access to safe drinking water; literacy rate, etc.

Composite indicators: These indicators encompass many facets and hence provide a better measure. Expec-

tation of life, growth rate, physical quality of life index, etc. are all comprehensive indicators. The **Physical Quality of Life Index (PQLI)** has gained popularity in recent times.^{6a} It consists of three components: Infant mortality rate, life expectancy at one year of age and basic literacy, in population above 15 years of age. All three components are adequate for international and intercultural comparisons because no society wants to let its infants die and all people want to live longer and to have access to basic literacy. For each component, the performance of individual countries is placed on a scale of 0-100, where '0' represents an absolutely defined 'worst' performance and '100' represents an absolutely defined best performance. The three indicators are averaged after scaling, giving equal weightage to each component. Thus the final PQLI measure is also scaled from 0-100. The index shows changes in performance overtime, even projecting into the future.

The PQLI is not meant to rank countries. It is meant to show where a country is placed in relation to the ultimate objective of "PQLI 100". It thus affords a country a chance to improve and bridge the gap. Thus the PQLI is a dynamic indicator and is sensitive to changes in the health situation. The PQLI for India in mid 80's was 43 while it was 94 for the USA.

BEHAVIORAL INDICATORS

These measure utilization of services provided, rates of compliance and a attitude of populations. Utilization rates indicate whether the health facilities provided are adequate, relevant, accessible and acceptable. Hospital occupancy rates, proportion of population receiving antenatal care, proportion of population visiting primary health centers, etc., are all important indicators of utilization.

The health services all over the world, since 1981, were geared towards achieving the goal of Health for All by 2000 AD. The WHO has defined some indicators to measure progress. The suggested *HFA indicators* are as follows:

Health policy indicators: Which reveal the level of political commitment towards health for all.

Social and economic indicators: Related to health: These indicate the overall development perspectives in a country.

Indicators of the provision of health care: These reflect the actual implementation of the stated policy.

Health status indicators: These indicate the benefit accruing to the population.⁷

Concepts of Disease

Nature of Disease

Disease is easier to appreciate and less abstract than health. Whereas health denotes a perfect harmony of the

different body systems, disease denotes an aberration of this harmony. This aberration may range from a biochemical disturbance to severe disability or death. Even a psychological dysfunction may be classified as disease.

It is important to understand the difference between the terms disease and illness. Disease may be defined as the biophysiological phenomena which manifest themselves as changes in and malfunction of the human body.⁸ Illness, on the other hand, is the experience of being sick. Disease refers to occurrence of something, i.e. body changes and malfunction. Illness refers to experience of something, i.e. being sick. Profound changes and malfunction may occur in the body without their being experienced by the patient. A classical example is hypertension, labelled as "the silent killer". Blood pressure may be markedly increased, yet an individual may not have any symptoms. Such a person has hypertensive disease, but he does not feel he has any illness. Conversely, a person may feel ill without having a disease. For example, snake bite by a nonpoisonous snake may result in palpitation, perspiration, fainting and even death. The reason is that strong emotion or belief, in this case about the snake being poisonous, can result in illness. Another example is that of a person fainting or going into trance or frenzy under the belief that he is possessed by a spirit. Thus people may feel ill in the absence of disease, just as they can have disease without feeling ill.

Cause of Disease

The concept of disease has evolved constantly over the ages: (i) In the "**miasma**" phase, disease was attributed to bad air and elements. Specific causes of diseases were unknown in this era. (ii) This was followed by the "**germ**" phase during which specific pathogens were recognised as the cause of disease. This phase marked a watershed in the concept of disease and the hunt for pathogens was carried out on a war footing. This gave an impetus to set up isolation wards and big hospitals.

Concepts of Prevention

The concepts of prevention as enunciated by Leavell and Clark have stood the test of time.⁹ The basic framework worked out by them has practical utility even today. The four phases of prevention are: (i) primary prevention (ii) secondary prevention (iii) tertiary prevention. These phases are further categorized into five levels of prevention as follows:

Primary prevention	Health promotion Specific protection
Secondary prevention	Early diagnosis and treatment
Tertiary prevention	Disability limitation Rehabilitation.

The various phases and levels of prevention are not exactly water tight compartments. Some aspects of each of the phases may be applicable while tackling specific diseases. The five *levels* of prevention as listed above can be restated in practical terms and recategorized as the following four methods of prevention:

1. Measures to eliminate or attack the agents of disease
2. Methods to attack the channels of transmission
3. Methods to reduce contact of the agent and the susceptible host
4. Methods to augment host defence mechanisms.

Primordial Prevention

It has come from a Latin word ‘primordium’ means beginning. It means prevention at a stage, when the risk factors have not yet developed. Primordial prevention is aimed to eliminate the development of risk factors, while primary prevention is aimed to reduce the risk of exposure. Primordial prevention is achieved by health education. Example being, information is imparted to school children for adopting and maintaining healthy lifestyles.

Primary Prevention

The process of primary prevention is limited to the period before the onset of clinical disease in an individual. Thus *activities directed to prevent the occurrence of disease in human populations* fall in this category. These activities are related to health promotion and specific protection.

Health promotion: Health promotion is an all embracing entity which goes much beyond prevention of only specific disease. It is the means to attain a state of “positive health”, or, at least, “freedom from disease”. Health promotion concerns activities within as well as outside the health sector. Examples of *activities within the health sector* are:

- Health education to increase awareness of health problems so that populations identify their health needs and become familiar with preventive strategies and the health facilities available. This is the only component which has a long-term and lasting benefit. Health education can also improve compliance with advice, medication and follow-up.
- Improved protected water supply systems. These again have a long-term impact.
- Improvement of environmental sanitation.
- Inculcation of healthy habits.
- Family life education.

Examples of *activities outside the health sector* having a bearing on health promotion are those aimed at increasing literacy, overall socioeconomic development and industrial production and those leading to improved agricultural policies and public distribution systems.

Specific protection: Specific protection has benefitted to a great extent by improved modern day medical technology. Technological break-throughs have provided adequate and appropriate tools for prevention. However, specific protection dates back to 1753 when James Lind advocated the use of citrus fruits to seamen in order to prevent scurvy. Jenner’s discovery of the smallpox vaccine in 1796 gave a further boost to strategies for specific protection. Mass chemoprophylaxis is also a modern tool of specific protection. Other *examples of specific protection* are as follows:

- Active immunization by vaccines against measles, polio, diphtheria, pertussis, tetanus, hepatitis B, etc.
- Passive immunization by gamma globulins for tetanus, rabies, viral hepatitis, etc.
- Nutritional supplementation in mid-day school meal program; ICDS program, etc. to prevent against PEM.
- Specific nutrient supplementation by vitamin A, iron and iodine (as iodised salt).
- Chemoprophylaxis with chloroquine to prevent against malaria in travellers to endemic areas.
- Use of protective goggles in industry.
- Chlorination of water supplies, etc.

Secondary Prevention

Secondary prevention comes into play after the disease process has been initiated in the human host. The aim of such an approach is to minimize the spread of disease and to reduce the serious consequences. This is achieved through **early diagnosis and treatment**. Early diagnosis and prompt initiation of treatment can be undertaken at various levels:

- a. In the general population or in an age specific population.
- b. In captive groups, such as school children, jail inmates and industrial workers.
- c. In a hospital or clinical setting.

Early diagnosis and prompt treatment offers benefits to the affected individuals as well as to their families and the community. It helps to reduce the transmission of infection and, hence, is considered as a method of prevention. As a preventive strategy, it is most useful for diseases with long incubation period or long latent period since sufficient time is available to prevent further progression of disease and to improve further progression of disease and to improve prognosis. In noncommunicable diseases, sufficient lead time should be available. *Lead time* refers to the time gained in the natural history of an evolving chronic disease when diagnosis is made early.¹⁰ It means that if carcinoma cervix is detected during the presymptomatic period, the ultimate prognosis may be better. Thus early diagnosis and prompt treatment can play a very important role. Prompt initiation of treatment should be backed up by efforts to improve compliance and reduce default.

Screening for disease is an important step, both in the general population and in high risk groups. This is especially useful in diseases like leprosy, tuberculosis, carcinoma cervix, diabetes, etc.

Tertiary Prevention

Tertiary prevention acts at the stage where disease has got established in the individual. It is a costly venture, though recent efforts at community based rehabilitation have tried to bring down the costs. Tertiary prevention can be applied at the last two levels of prevention. These are:

Disability limitation: Here the disease has progressed significantly and has caused some loss of function of a temporary or permanent nature. The idea is to provide relief to the affected individual so that a total handicap can be prevented. This mode of prevention can be illustrated by the example of leprosy. Leprosy can lead to irreversible ocular damage and blindness when left untreated. If multidrug therapy is instituted even after some ocular damage has occurred, total blindness can still be prevented.

Rehabilitation: Rehabilitation can be considered as a preventive measure in that if effectively utilized, it can prevent further social drift of the affected individual. *Social drift* is the phenomenon of going down the social ladder due to loss of ability to generate income caused by disease.

Rehabilitation is an extremely costly venture. The aim of rehabilitation is to integrate the affected individual in the community by optimizing his functional ability. It involves psychological, vocational and social and educational intervention.

Psychological rehabilitation is of acute importance as, immediately after experiencing a handicap, the hitherto normal individual may not be able to cope up with the new stress situation. This is known as *crisis intervention*. The individual needs to be made to understand the importance of life and how he can cope with the new situation.

If the handicapped have to lead a normal life and are to be accepted by the members of the family and

the community, *vocational rehabilitation* is very important. Creating job opportunities and training the handicapped for such jobs go a long way in alleviating their suffering. Legislation to accord preferential treatment to the handicapped is also needed. *Social rehabilitation* is extremely important to provide adequate support to the handicapped individual. The family members should be taught to maintain social support and involve the disabled in domestic affairs. Stigma attached to disease should be tackled by effective education.

Sometimes the handicap may be of such an extent that vocational rehabilitation may not be possible. An example is severe mental retardation. In such a situation, rehabilitation efforts should be geared to train the individual in activities of daily living.

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Epidemiological Approach in Preventive and Social Medicine

Dictionaries define epidemiology as the scientific basis for public health and, especially, preventive medicine.¹ In keeping with this concept, the present book is patterned on the epidemiological approach, which is symbolized in the triad of host, agent and environment. To put it rather picturesquely, just as there are three components in a drama on the stage, there are three components in the drama of disease as well. The stage drama or a movie is built around a hero, a villain and the life circumstances in which they operate and interact. The disease drama has similar components of hero (the host), villain (the agent of disease) and circumstances (the environment). To summarize, the three epidemiological components of a disease situation are:

1. The host or the man who enjoys health or suffers from disease (The World Health Organization defines health as *a state of complete physical, mental and social well-being and not mere absence of disease or infirmity*).
2. The agents, whether living (such as bacteria and viruses) or nonliving (such as radiation, temperature and minerals, e.g. lead, fluorine).
3. The environment comprising of food, air, water, housing, place of work, etc. which surround both the host and the agent and in which both interact.

The host, the agent and the environment are discussed in detail later in this chapter. The outcome of the host-agent environment interaction may be in the nature of health, discomfort, disability, disease or death. Thus all individuals in a population group may be equally exposed to the same agent and environment, yet some may totally escape the disease, others may get only a mild attack while yet others may develop the full blown disease which may culminate in death. This is so because the exact outcome is determined by host factors inherent in each individual. These are described detail in Chapter 14.

Concept of Epidemiology

Epidemiology is a scientific study of factors and conditions related to disease as they occur in people. The word epidemiology is derived from *epi* (in, on, upon); *demos* (people) and *logos* (science). Formerly,

epidemiology was considered to be a science of epidemics and its application was limited to prevention and control of a few communicable diseases such as cholera, smallpox, plague, etc. which occurred in epidemic form. Gradually, the epidemiological method of studying a disease by devoting attention to its occurrence and distribution, etiology, prevention and control was extended to communicable diseases in general. During last few decades, the epidemiological approach has been used in the study of noncommunicable diseases also, such as hypertension, coronary artery disease, diabetes, cancer, mental disorders and even accidents and burns. As a result, diseases are now broadly classified into two groups—communicable and noncommunicable—for the purpose of epidemiological study.

Definition of Epidemiology

As the scope of epidemiology has enlarged over the years, the definition of epidemiology has also changed from the previous narrow definition as “the branch of medical science dealing with epidemics” as suggested by Parkin in 1873. Some broader definitions are given below:

- It is an orderly study of incidence in human society of any morbid state (communicable and non-communicable disease, accidents, injuries and abnormalities of medical importance).
- It is a study of the role of the agent, host and environment in the natural history of disease.
- It is the study of relationship among various factors and conditions in the agent, host and environment that determine the frequency of occurrence and distribution of an infectious process; a disease or a physiological state in a population.
- According to Lilienfeld, “Epidemiology is the study of the distribution of a disease or a physiological condition in human populations and of the factors that influence this distribution”.²
- The study of the frequency, distribution and determinants of disease (International Epidemiological Association).

- The study of the distribution and determinants of health related states and events in populations and the application of this study to control health problems.³

Out of the above definitions the last one is the most modern. To put it even more simply, “epidemiology is the study of *distribution* and *determinants* of health related *events* in *population*.”⁴ The meaning of four words in this definition needs to be explained for a proper understanding of this definition.

Events

Health related events include disease, disability, physiological conditions and different states of health.

Population

It includes both human and animal populations. Epidemiology is now extensively used for study of diseases in animals.

Distribution

It refers to distribution of the event in relation to time, place and person. The description of such distribution is known as **descriptive epidemiology**. The aim of descriptive epidemiology is to discern trends (increasing or decreasing) in occurrence of the disease over the years, over geographical areas or over different populations. (The population here is used in the statistical sense and means a group of individuals sharing one or more specified characteristics).

Determinants

These refer to the etiological or risk factors related to a particular disease or health state. When these factors are studied and analyzed along with information from other disciplines (such as genetics, biochemistry, microbiology, immunology, etc.), the field is known as **analytical epidemiology**.

The Epidemiological Triad

The occurrence and manifestations of any disease, whether communicable or noncommunicable, are determined by the interactions between the agent, the host and the environment, which together constitute the epidemiological triad (**Fig. 3.1**). Each of these is treated as a separate component, though many epidemiologists consider the agent as part of the biological environment of man.

The Agent

The agent is defined as an organism, a substance or a force, the presence or lack of which may initiate a

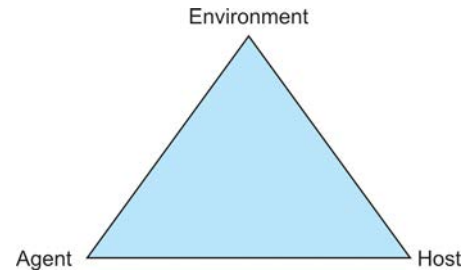


Fig. 3.1: The epidemiological triad

disease process or may cause it to continue. There may be single or multiple agents for a disease.³ These may be classified into:

- Living or biological agents.
- Nonliving or inanimate, classified further as nutrient, chemical and physical agents.

The various types of agents are listed below:

Biological Agents

- Arthropods: Examples are mites and lice, causing pediculosis and scabies respectively. However, the role of arthropods in disease transmission is much more often as vectors of other agents such as malarial parasite, rather than as agents themselves.
- Helminths
- Protozoa, of which about 20 are parasitic in man
- Fungi
- Bacteria
- Viruses.

Much is known about biological agents now. Their detailed study constitutes the speciality of microbiology. Their epidemiological characteristics in relation to man and environments are discussed under “General Epidemiology of Communicable Disease”, Chapter 15.

The attributes of biological agents are as follows:

- Inherent nature and characteristics” Morphology, motility, physiology, reproduction, metabolism, nutrition, temperature requirements, toxin production, etc.
- Viability and resistance: Susceptibility of the organism to heat, cold, moisture, sunlight, etc.
- Characteristics directly related to man:
 - Infectivity or ability to gain access and adapt to the human host
 - Pathogenicity or ability to set up a tissue reaction
 - Virulence or severity of reaction
 - Antigenic property.

Nutrient Agents

The known agents in relation to food and nutrition are energy, protein, carbohydrate, fat, vitamins, minerals, water and fibre. Their nature and role in health and disease are discussed in detail in Chapter 22.

Chemical Agents

They are chemical substances of two types:

1. *External agents* such as lead, arsenic, alcohol, dust, stone particles and carbon.
2. *Internal agents* produced in the body itself as a result of metabolic disorders or dysfunction of endocrine glands. Examples are urea (uremia) in renal failure and ketone bodies (ketoacidosis) in diabetes mellitus.

Physical Agents

Important ones are atmospheric pressure, temperature, humidity, friction, mechanical force, radiation, light, electricity, sound and vibration.

Chemical and physical agents occur within the broad physical environment comprising of air, water, food, place of living and place of work, etc. They are hence discussed in the subsequent chapters dealing with environmental factors.

The Host

The host is the man himself. The characteristics of a human being that determine how he reacts to the agents in the environment are called host factors. Also, man has an important role in disease transmission. Many organisms have established biologic relationships with man, to the extent that their propagation depends on finding a portal of entry in man, multiplying in the tissues and coexisting with the human host.⁵ The host factors influence exposure, susceptibility and response to an agent.²

DEMOGRAPHIC CHARACTERISTICS

Age, sex, race (ethnicity).

BIOLOGICAL CHARACTERISTICS

Genetic background (e.g. blood groups), physiological and biochemical characteristics (e.g. serum lipid, blood glucose levels), immune status, nutritional status, personality.

SOCIOECONOMIC CHARACTERISTICS

Economic status, social class, religion, education, occupation, marital status, place of living, etc.

LIFESTYLE

Living habits, food habits, use of alcohol, tobacco, drugs, etc. degree of physical activity, personal hygiene, etc.

Each of the factors listed above has been shown to be associated with health and disease. Host factors are described in detail in Chapter 14. However, a brief description of important host factors determining disease is given below:

Genetic endowment: The genetic constitution either increases susceptibility to disease or may protect against it. HLA markers are used to gauge susceptibility of individuals to specific diseases. Hemophilia, diabetes, color blindness, sickle cell disease, G-6-PD deficiency, etc. are all related to the genetic endowment.

Age: Age is a strong determinant of health. Diseases like measles, whooping cough, diarrhea, etc. are commonly encountered in children. Diseases like cataract, parkinsonism, etc. are seen at older ages. Age actually has an indirect role. Children contract diseases because of lack of protective immunity while the aged suffer because of degenerative changes.

Sex: Sexual differences are documented and may be due to metabolic or structural differences, differences in exposure or even to genetic background. Hemophilia and gout are seen only in males while carcinoma cervix and rheumatoid arthritis are female prerogatives.

Race: Racial differences are well known. Angle closure glaucoma is common in South East Asia. Sickle cell anemia is common among negroes.

Marital status: The pattern of disease in the married and the unmarried tends to differ. Sexually transmitted diseases are common in unmarried adults.

Nutritional status: Examples of disease conditions related to poor nutritional—status are contracted pelvis due to osteomalacia in women (Vit. D deficiency), Wernicke's encephalopathy in alcoholics (thiamine deficiency) goiter in endemic areas (iodine deficiency) and neurological lesions in fluorosis (fluoride excess).

Other host factors of importance are immune status, occupational status, socioeconomic status, literacy status, lifestyle and habits and human mobility and migration.

It may be mentioned that in terms of infectious disease epidemiology the definition of host is necessarily wider. In that context, *host is defined as a person or an animal, (including arthropods and birds) that afford subsistence or lodgement to an infectious agent under natural conditions.*³

The Environment

In operational terms, *health* has been defined as “a condition or quality of the human organism expressing the adequate functioning of the organism in given conditions, genetic or environmental”.⁴ The environment of man is of two types—internal and external.

1. *Internal environment* is comprised by the various tissues, organs and organ systems within the human body. Internal environment is directly related to internal health and falls within the domain of internal medicine. In internal health, each component part of the body is functioning smoothly, efficiently and harmoniously. Fault in functioning of one or more component parts results in disharmony or disease. For example, dysfunction of liver affects not only

digestion but also the mental and physical functioning of the body as a whole.

2. *External environment* is defined as “all that, which is external to the individual human host”³ and is comprised by those things to which one is exposed after conception. *Macroenvironment* is another term used to denote external environment. On the other hand, the term *microenvironment* is sometimes used to denote one’s personal environment comprised by the individual’s way of living and lifestyle. Adjustment to stimuli or agents in the external environment is very important. The man or host is making constant endeavor to maintain health by adjustment to all sorts of agents in the external environment. When the host, i.e. man, is well adjusted, he is in a state of comfort or health. Maladjustment of body creates an imbalance or disharmony which is responsible for discomfort or disease. This adjustment or maladjustment of man to agents in the environment is the *ecological concept of health* or disease.

This concept is clarified in the following examples:

- Heatstroke is the result of interaction between high temperature (agent) and body (host) in an environment characterised by hot, humid and still air. This is an example of failure of adjustment by man to heat in an unfavorable environment. Had the environment been favourable (i.e. dry wind in place of humid, still air), the high temperature would not have resulted in heatstroke.
- Man may frequently come in contact with tuberculosis germs, but he gets the disease only when he cannot adjust to them. If the germs are exposed to sun, they die; if man’s resistance is good, he is not affected. If the person is exposed to the tuberculosis bacilli too often in a closed room and his resistance is low, he may succumb to the infection and may get the disease.

Environment is the source or reservoir for the agents of disease. It helps in the transmission of agents to the host, bringing about their contact and interaction. During such interaction, the environment may be favourable to man and unfavorable to the agent or vice versa. Thus there is a constant attempt towards adjustment and re-adjustment between the man and the causative agents within the same environment. If adjustment is achieved, there is health, harmony or symbiosis. Maladjustment or imbalance between the two results in disharmony, discomfort, disease or death.

The environment may be living or nonliving and the former may be biological or social. Generally we study the environment under three headings—physical, biological and social.

Physical environment is the space around man containing gases (air), liquids (water) and solids (food, refuse, soil and various objects at the place of work or living). The physical factors include soil, climate, seasons,

weather, humidity, temperature, machinery and physical structures. Soil is related to worms, climate to heatstroke or frostbite, seasons to vector breeding, machinery to accidents and damp buildings to ARI, etc. In the physical environment there may also be included the various chemicals and chemical pollutants found in the physical space around man. These include a large number of industrial and agricultural chemicals as well as insecticides such as DDT.

Biological environment means the universe of all living things that surround man, except the human beings. It comprises both animals and plants. They may be reservoirs of disease germs (e.g. rats in case of plague); they may be transmitters of disease agents (e.g. mosquitoes) or they may themselves be the causative agents of disease, (e.g. bacteria and viruses).

Social environment comprises all human beings around the host (the man) and their activities and interactions. It may be considered under two headings—social and economic factors.

1. *Social factors* pertain to the society in which man lives. Society, in this context, includes other family members, neighbours, other members of the community and the State or Government organisation. Social factors produce stimuli that affect the physical, mental and social state of man to which he must adjust. For example, the size of the family affects the health of the family members. The temperament of the spouse, the attitude of the office boss, the customs of the society and the laws of the land, all play upon the man and influence his physical and mental health.

Urbanization and industrialization, with consequent problems like overcrowding, tensions, competitiveness and exposure to toxic effluents, are also important. Disruption caused by famine, war, riots, floods or cyclones also affect the social environment. Broadly speaking, overall socioeconomic and political organization affect the technical level of medical care, the system by which that care is delivered, the extent of support for medical care and biomedical research and the adequacy and level of enforcement of codes and laws controlling health related environmental hazards. Another important aspect of the social environment is the receptivity to new ideas. It is possible for resistance to develop when certain practices run counter to medical preaching.⁶

2. *Economic factors* refer to the material assets and gains of the human economic society. Economic factors determine the economic status of man, which decisively affects his health. Thus low economic status means less diet, less education and enlightenment, poor housing and less resources for medical aid.

The host or man acclimatizes or adjust to agents or stimuli from the environment by virtue of the adaptability inherent within him. The skin exposed to

constant irritation becomes thick. Opium addicts and alcoholics can tolerate large amounts of opium or alcohol. A man from tropical Africa can easily tolerate the hot climate that would be unbearable for a man from Moscow or Northern Canada. When a person fails to acclimatise or to protect himself against living or non-living stimuli from the environment, the consequence may be discomfort, disability, disease or death. Thus the objective of studying *human ecology* or science of adjustment of man to his environment is to provide him with health-giving surroundings. This, in other words is the concept of *environmental health*.

Health environment is a common need of all people, cutting across the boundaries of occupation, race, class and politics. Provision of healthy environment is a major phase in the community health program and is an evidence of the degree of civilization attained by the country. It can be achieved only through the combined efforts of the individual, the society and the state. The provision of healthy environment includes attention to all the three components of environment viz., physical, biological and social. A proper physical environment implies clean air, soil, water, food, housing and place of work, which should be so conditioned as to be comfortable and health-giving. A proper biological environment implies flora and fauna in the surroundings with which man is well adjusted and which are not harmful to him. A proper social environment implies adequate provision of health, education, work and recreational facilities for the individual and his or her family. It should be the duty of the state to provide security to the individual against injury, illness, unemployment and other wants. It can be stated with certainty that any expenditure on providing a healthy environment to the people is a sound investment yielding immediate and steady returns.

Having discussed the agent, host and environmental factors above, it needs to be emphasized that they are not mutually exclusive. Firstly, the same substance or factor may act as the agent and the environment in different situations. A good example is that of food and nutrition. Food may act as agent of disease through deficiency or excess of nutrients (e.g. protein energy malnutrition, nutritional anemia, fluorosis, obesity, xerophthalmia and hypervitaminosis A). It may also act as environment in the sense that it acts as vehicle for agents of disease (streptococcal food poisoning, salmonellosis, cancer due to carcinogens in food such as coal tar dyes and aflatoxins). Moreover, nutrition even acts as a host factor because nutritional status is an important determinant of disease. It is in view of this special attribute that Food and Nutrition (Chapter 22) forms a separate section, distinct from the sections on Agent, Host and Environment. *Secondly*, man (the host) himself is ultimately the cause of many diseases or disabilities. For example, the cause of protein energy malnutrition may be less food availability and intake but this, in turn, is

because of man's greed and selfish nature that cause him to amass wealth, with the resultant poverty in certain segments of society. Another example is obesity, which is due to energy intake in excess of energy expenditure. Here man himself is responsible for the disease, because both the intrinsic etiological factors (genetic traits) and the extrinsic factors (overeating and a lifestyle characterised by too little physical activity) lie within the host himself.

In the earlier years, when the focus of epidemiologic studies was centered around infectious diseases, agents were categorized as a separate and important category. But with the recent application of epidemiological methods to noninfectious diseases, the newer epidemiologic model tend to deemphasize agent factors and lay stress upon the multiplicity of interactions between the host and the environment.⁶

Web of Causation

In many diseases, especially noncommunicable diseases, the causative agent may be unknown or uncertain, yet there may be definite association of the disease with several known factors or groups or chains of factors which may interact with each other. Thus there may be neither a clear cut etiological triad, nor a clear cut cause and effect diad, but rather a web of factors or chains of factors. This has been referred to as the Web of causation by Mc Mahon and Pugh, who used this term for the first time. An example of the Web of causation in reference to ischemic heart disease is given in the accompanying diagram.

Epidemiological Wheel

This is another approach to depict man-environment interrelationships. The wheel consists of a hub which represents the host and its core is composed of genetic endowment. The hub is surrounded by the three major divisions of the environment, namely, physical, biological and social. The sizes of the different components of the wheel depend upon specific disease entities. In genetic diseases the core will be very large. This model also deemphasizes the agent, stressing more on host-environmental interactions. But, unlike the model of the web, it does give separate identities to the host and the environment.⁶

Natural History of Disease

This term refers to the course that a disease would follow from its inception to its end without any external intervention. Because internal intervention will always be there in the form of immunity. It can be broadly divided into two stages—the stage of prepathogenesis and the stage of pathogenesis. The concept of prepathogenesis and pathogenesis is described below.

Every disease process has multiple etiology. These multiple causes may be classified as agent, host and environmental factors. The disease itself results when the balance between the agent, host and environmental factors gets tilted in favor of the causative agent. One or more of these factors may start operating long before the disease actually manifests itself. For example, the occurrence of repeated attacks of chickenpox or measles (single attacks of which usually confer life long immunity) is determined not by the virulence of the infective agent but by the presence of agammaglobulinemia, which may be congenital.⁷ Keeping this long temporal spectrum in view, the total disease process can be divided into two periods, the period of prepathogenesis and the period of pathogenesis. In the above example, with reference to the occurrence of a repeat attack of measles in a person with genetically determined agammaglobulinemia, the period of prepathogenesis is the period from conception till the time of second contact with measles virus, while the period of pathogenesis is the period from repeat contact with the virus till the actual occurrence and subsidence of the second attack of measles. These concepts are further explained below.⁸

Prepathogenesis refers to the interaction between the potential agent, host and environmental factors which interact before man is directly involved and which ultimately determine the actual occurrence of disease in man. It starts from the time the first forces start operating to create the disease stimulus in the environment or elsewhere. An example of environmental factors as the initial force is the extreme cold in Kashmir responsible for the use of Kangari by man (the host) in whom the chronic irritation of skin by local heat (the agent) causes the Kangari cancer. An example of a disease where the agent factor constitutes the initial force during prepathogenesis would be the occurrence of gonorrhoea in a person who had been given otherwise adequate doses of penicillin prophylactically and therapeutically because he is infected by a penicillin resistant strain. In this case, the development of penicillin resistance constitutes the initial prepathogenetic force referable to the agent.

Pathogenesis refers to the course of the disorder in man from the first interaction with disease provoking stimuli till the appearance of the resultant changes in form and function or till the attainment of equilibrium or till the occurrence of recovery, defect, disability or death. In the example of gonorrhoea above, the period of pathogenesis starts from the moment man comes in contact with gonococci till he gets rid of the infection and the pathological process in the body has stabilised. The period of pathogenesis consists of the preclinical phase (before the occurrence of clinical signs and symptoms) and the clinical phase (from the time of clinical presentation onwards).

To summarize, the natural history of disease covers two processes:⁸ prepathogenesis (the process in the

environment) and pathogenesis (the process in man). These processes are described below in detail. They are clarified in the accompanying **Table 3.1**. The description of prepathogenesis will be aimed at the agent, host and environmental factors that interact and lead to the stage of pathogenesis. The description of pathogenesis will cover the temporal profile of the period of pathogenesis in the individual and the community.

TABLE 3.1: Stages of disease in man

Stage of Prepathogenesis

This is the stage at which man is not involved by the disease process. During this stage, however, the agent, host and environment interactions bring together the agent and the host or produce a disease provoking stimulus in the human host.

Stage of Pathogenesis

• *Preclinical Phase*

- Agent (or stimulus) becomes established in the host and increases by multiplication.
- Changes occur in the body in response to the agent. These changes may be related to immune resistance, physiological function or tissue morphology.

• *Clinical Phase*

- Active clinical illness with characteristic signs and symptoms
- Convalescence
- Chronic illness
- Disability and defect
- Recovery or death

Prepathogenesis

AGENT FACTORS

These are grouped into three categories—those inherent in the agent; those related to man; and those related to environment.

Agent Factors Inherent within the Agent

- Biological such as morphology, life cycle, motility, temperature, oxygen requirements for growth and toxin production.
- Physical, such as resistance and viability when exposed to heat, drying, ultraviolet light, chemicals and antibodies.
- Chemical, such as antigenic composition.

Agent Factors in Relation to Man

In most cases, man is the host as well as the reservoir or source of infectious agents. Many agent factors are thus related to man. These are as follows:

Infectivity: It is the ability of the biological agent to invade or enter the host and then multiply. For example, *Cl. tetani* and *C. diphtheriae* have low infectivity but high pathogenicity and virulence.

Pathogenicity and virulence: Pathogenicity is the capability of an infectious agent to cause disease in a susceptible host while virulence is the degree of

pathogenicity of an infectious agent, indicated by case fatality rate and/or its ability to invade and damage tissues of the host.⁸ Tubercle bacillus has got high pathogenicity but low virulence. Only about 1% of the persons who get infected develop the disease. Virulence is also low in case of pneumococcal, herpetic and fungal infections. Rabies virus, on the other hand is highly virulent. Some microorganisms throw variants after turnover of a few generations. Such variants may have altered virulence and antigenicity.

Antigenicity: It means ability of the agent to stimulate the host to produce antibodies such as agglutinins, precipitins, antitoxins, bacteriolysins, complement fixing, neutralizing and sensitizing antibodies. They provide specific protection and are helpful in diagnosis of the causative microorganism. The specific antibodies in serum are demonstrable about a week after the onset of symptoms. This fact is of value in establishing the diagnosis of diseases like enteric fever, brucellosis, leptospirosis and infectious mononucleosis. Antibodies may be demonstrable in virus infections also, but clinical identity is clear by the time diagnosis is made by this method. Helminthic antigenicity is made use of in diagnosis by allergic skin tests, such as those for trichinellosis and hydatidosis. Protozoa produce complement fixing antibodies. Rickettsiae usually result in lasting immunity while viruses generate varying degrees of specific immunity. High pathogenicity is often associated with high antigenicity. High infectivity and low pathogenicity produce passive carriers and mild cases, as seen in meningococcal infection.

Agent Factors in Relation to Environment

The main role of the environment is either as reservoir of infectious agents or as vehicle of transmission. Both the roles depend on the morphology and the viability of various agents.

Factors in relation to reservoir

Human reservoir: Man is an important source or reservoir in most of the infections in two ways: as a case or as a carrier. Definitions of various types of carriers have already been given. Examples of a temporary carrier are healthy contacts of cases of diphtheria, poliomyelitis, etc. Examples of an incubatory carrier are diphtheria contacts who may be carrying organisms in the incubation period. Examples of convalescent carriers are patients who have recently recovered from typhoid, dysentery, cholera and diphtheria. Examples of chronic carriers are persons who have been infected with organisms causing dysentery or typhoid and pass these organisms in stools for a long time. Such discharge may be intermittent.

Animal reservoir: Domestic animals and pets are important reservoirs. Examples are dogs (rabies), rats

(plague, leptospirosis, typhus, rat bite fever, salmonellosis), horse (glanders), sheep and goat (anthrax) and cow (brucellosis).

Inanimate reservoir: Soil, water and sewage form secondary reservoirs for varying lengths of time. Soil may act as reservoir for spore bearing organisms like *Cl. tetani*. Water and sewage may be temporary or long time sources for infections like cholera, typhoid and poliomyelitis.

Factors in relation to transmission: All types of environment—physical, biological and social—may act as vehicles of transmission. The examples of physical category are fomites and infected food and water. Examples of biological environment as vehicle of disease are provided by the large number of vectors such as mosquito and flea. The social environment operates in case of disease requiring close human contact for transmission, such as venereal diseases (genital contact, direct transmission), leprosy (skin contact and droplet transmission) and many viral and bacterial infections such as measles, diphtheria, influenza, etc.

HOST FACTORS

These relate to the characteristics inherent in the host or man himself which make him susceptible or resistant to infectious agents. These have been described in detail in the previous chapter. Some further examples will be given here to illustrate the role of host factors in infectious disease epidemiology.

Age is a very important host factor in the context. A child under 6 months is resistant to measles but is very susceptible to it from 6 months to 2 years. Pertussis is most dangerous to children under 2 years of age. Communicable diseases common in childhood become rare in later life.⁹ Typhoid is more common from 5 to 25 years of age.

Sex differences in relation to communicable diseases may be explained differently in different instances. Thus leprosy is more common in males, but this may be because of more chances of exposure in men.¹⁰ *E. coli* infection of the urinary tract is more common in women because of anatomical differences and the proximity of urethral and anal orifices. AIDS is particularly common in passive homosexual men because rectal mucosa offers little resistance to the virus, as also because anal intercourse is usually associated with some bleeding from rectal mucosa.

Race differences in communicable diseases may be related to socioeconomic, geographic and ethnogenetic factors. The latter are known to influence the prevalence of malaria in different regions. It has long been known that negroes in the USA had *P. vivax* infection rate lower than that of whites and that it was more difficult to infect them with this species. The most evident consequence of resistance to *P. vivax* in negroes occurs in West Africa

where, in many regions, it cannot be found in the indigenous population; yet the parasite is common in the inhabitants of the Eastern Congo and East Africa.¹¹

Genetic factors determine the occurrence of sickle cell trait, sickle cell disease and other hemoglobinopathies. The affected individuals are more prone to infections, especially those caused by *Salmonella* and *Pneumococci*. Osteomyelitis is also common in them and frequently leads to death.¹²

Personality can also influence the incidence of infectious diseases. Some persons are very health conscious and meticulous in their hygiene, thus minimising chances of infection. Some people seek prophylactic vaccinations and inoculations on their own, while others refuse them even when approached at their home. Some individuals are sexually extravagant and are repeatedly exposed to venereal diseases. Thus personality traits definitely act as determinants of disease.

Various **habits and customs** are also important. The habit of washing hands before meals protects from diseases like cholera. The custom of easing in open fields helps in the spread of hookworm infection. General and specific defence mechanisms of the body are of crucial importance influencing the occurrence and severity of infections.

ENVIRONMENTAL FACTORS

They play an important role in favor of either the agent or the host and have been described in detail in earlier chapters. The role of environmental factors in infectious diseases will be further illustrated here by appropriate examples.

Social environment: Indiscriminate defecation increases the chances of water and soil pollution. Poverty and overcrowding lower the body resistance and increase the chances of infection. Availability of good food and nutrition and facilities for immunization increase resistance to diseases. Better economic and social environment ensures better medical and health facilities.

Physical environment: Altitude, soil, climate, rainfall, water-supply, etc. may favor growth or spread of agents and their vectors and reservoirs.

Biological environment: Arthropods, pets, livestock or beasts may act as source of infection or may transmit the same. Man lives in close contact with animals like cow, pig, goat, etc. and often, even ingests them. Thus, he is liable to contact diseases like brucellosis, hydatidosis and cysticercosis.

Pathogenesis

Everyone is potentially in a phase of prepathogenesis with respect to some diseases. However, the period of

pathogenesis starts only when the infectious agent enters the host. Once that happens, one of the following possibilities may occur.

- *The agent fails to lodge within the body:*
 - It may be coughed or sneezed out, passed out in stools or washed off from the skin or mucous membrane.
 - It fails to enter the skin or mucous membrane because of intactness, the first line of defence.
 - It is dealt with by phagocytes or reticuloendothelial cells or is killed by secretions such as hydrochloric acid in stomach, the second line of defence.
- *The agent is able to lodge and multiply but fails to produce obvious disease:* Examples are asymptomatic *Meningococcal* infection and many cases of helminthic infections, e.g. *Enterobiasis* and *Ascariasis*.
- *The agent lodges, establishes and multiplies within the body producing a series of changes,* which may be detectable by clinical or laboratory examination. From a clinical point of view, pathogenesis has two distinct phases: preclinical phase (incubation period) and clinical phase.

PRECLINICAL PHASE

During this period, the parasite lodges, multiplies and starts the disease process in the host but the symptoms and signs are neither felt by the prospective patient, nor are they apparent to the doctor on clinical examination. *Incubation period* may, thus, be defined as the length of time, reckoned from the point of entry of the parasite into the host, till the clinical manifestation of disease. Incubation period varies from disease to disease. Information about mean and range of incubation period of a disease helps in diagnosis of the disease, in tracing the source of infection and in fixing the period of quarantine.

CLINICAL PHASE

The disease becomes clinically manifested in this phase. The severity of illness in an individual again depends on agent, host or environment factors. It may manifest in the following forms:

- Mild, missed, ambulatory or atypical case, ending in complete recovery
- Acute case ending in recovery, disability, chronicity or death.
- Chronic case ending in recovery, disability or death.

INFECTIOUS DISEASE MORBIDITY

Morbidity is measured as incidence or prevalence rates, which are expressed as the number of cases per unit population (per thousand, lakh or million). When it applies to occurrence of new cases, it is called incidence rate. When applied to both new and old cases, it is called

prevalence rate. Details are given in the chapter on vital statistics. *Variation in incidence or prevalence* of a disease in a given population depends on the agent, host and environmental factors and is of three types.

1. *Short-term fluctuations* result in an increase (or decrease) in the number of cases in a community. Common examples are outbreaks of diarrhea, cholera and infective hepatitis, which may assume the shape of an endemic or epidemic;
2. *Periodic fluctuations* may be seasonal or cyclic in nature. Examples of *seasonal fluctuations* are the high incidence of upper respiratory infections in winter and of cholera in rainy season. Examples of *cyclic fluctuations* are the occurrence of influenza pandemics every 7 to 10 years, of rubella every 6 to 9 years and of measles every 2 to 3 years. Such fluctuations are probably related to herd *immunity*. The proportion of susceptible individuals in the “herd” increases year after year with the result that an outbreak occurs.
3. *Secular fluctuations* refer to changes in morbidity rates over a long period of time, often decades. Examples are a decreasing trend in occurrence of diphtheria and polio.

Change in incidence of an infective disease is best judged in relation to incidence pattern in the past as reflected in monthly incidence records for last 5 to 10 years. Mean monthly incidence for each year is calculated at first. An increase through 2 standard deviations serves as a warning and an increase through 3 standard deviation calls for active community control measures. The following terms are used to express various grades of incidence and prevalence of communicable diseases in a community.

Mild incidence: When less than 3 new cases per week are reported in 100,000 population.

Considerable incidence: When 3 to 5 new cases/100,000/week occur.

Heavy incidence: When 5 to 10 new cases/100,000/week are reported.

Epidemic: When the number rises to ten or more/100,000/week.

Outbreak: When there is sudden reporting of a large number of new cases, the population having been absolutely free earlier. Food poisoning and cholera often breakout suddenly.

Endemic: When the infectious agent has taken a foothold in a population which is naturally and partially protected because of occurrence of the disease over a period. Reporting of a few new cases goes on throughout the year. Examples are typhoid, diphtheria and infective hepatitis. When the incidence rises due to changes in the agent, host or environment factors, it becomes an epidemic.

Sporadic: When only isolated cases are reported here and there, now and then. There is no tendency to spread at one place or at one time. This may happen in case of meningitis and poliomyelitis.

Pandemic: When an epidemic appears simultaneously or successively in more than one country, e.g. the influenza epidemic in 1957-58.

Epizootic and enzootic: These terms are used in animals and are comparable to ‘epidemic’ and ‘endemic’ in man. Plague may be epizootic in rats while rabies is enzootic in dogs. Zoonoses are diseases that are transmitted naturally between man and vertebrate animals.¹³ Examples are plague, rabies, anthrax, brucellosis, hydatid disease, kysanur forest disease and typhus.

Exotic: This is the label given to a disease imported from outside and not present in the country earlier. For example, if cases of yellow fever occur in India one day, it will be an example of exotic disease.

An epidemiologist may be able to forecast an epidemic on the basis of known agent, host and environment factors. For example, an epidemic of malaria may be expected when there is high rainfall and humidity. An epidemic of AIDS is feared in large parts of the world at present.

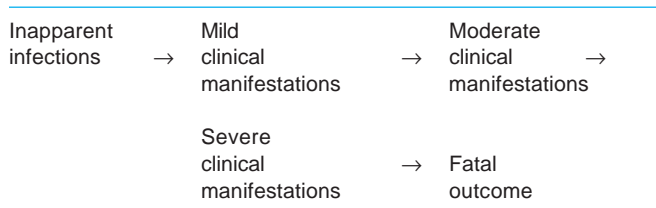
SPECTRUM OF DISEASE

The spectrum of disease may be defined as the sequence of events that occur in the human host from the time of contact with the etiologic agent up to the point of the ultimate outcome, which may be fatal in the extreme cases. The spectrum is conventionally divided into two components—the subclinical and the clinical stage. Progression through the spectrum can be decelerated or halted by preventive or therapeutic measures.² Conditions where proven strategies for effective prevention or treatment are available can be halted with relative ease compared to conditions which do not have established intervention strategies.

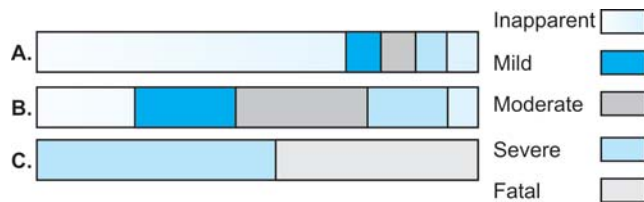
The term spectrum of disease is synonymous with “*gradient of infection*” in relation to infectious conditions. The gradient of infection refers to the sequence of manifestations of illness in a host, reflecting host response to the infectious agent.³ Clinicians are generally aware of only a small proportion of the spectrum of a given disease and the gradient of infection. This is what is called “The tip of the iceberg” as information on the submerged portion is not available. But the inapparent cases are important for their role in transmission. Latent infections should be differentiated from inapparent infections as, during the latent period (unlike during the inapparent period), the host does not shed the infectious agent, which lies dormant in the host tissues. Since many inapparent infections can be transmitted and can

produce disease in others, it is not sufficient to direct disease management procedures solely to clinically apparent cases.

The *gradient of infection* is as follows:



Infections can be categorized into three groups, each represented by the bars illustrated below:



“A” describes infections, a high proportion of which are inapparent with only a small fraction of clinically evident cases. For example, tuberculosis, viral hepatitis, polio, etc. “B” represents infections in which the inapparent component is relatively small as is the proportion of fatal cases. For example, measles, chickenpox, etc. “C” represents infections with a severe or fatal outcome. For example: AIDS, rabies, tetanus, etc.

Regarding “A”, it is seen that only a small proportion with obvious disease or severe symptoms will come to medical attention and, therefore, statistics on these infections will be low and misleading.⁶ These are the diseases where what is seen by a clinician is only the tip of the iceberg.

In studying the progression of infectious disease in a community or population group, the aim of community medicine is to identify the focus of infection and to attempt to stop the spread of disease. In this respect it is important to differentiate between the primary and the index case. The *primary case* refers to the individual who introduces the disease into the family or the community. The *index case* refers to the individual who first comes to the notice of the health system. Epidemiological investigation begins with an index case and then both forward and backward linkages are established. At times a number of primary cases may have introduced the infection into the community at approximately the same time. These are then termed as *coprimaries*. Cases resulting from transmission of infection from the primary case are termed as *secondary cases*. The peak of the number of secondary cases is separated from the primary case by one incubation period.

The *incubation period* refers to the time duration between the receipt of the infective organism by the susceptible host and the first clinical manifestation of

disease. The *factors affecting the length of the incubation period* are as follows:

- Dose of inoculum: The smaller the inoculated dose, the longer is the incubation period.
- Site of multiplication of organism: When the organism multiplies exclusively at or near the portal of entry, the incubation period tends to be short, as in case of gonorrhoea and tetanus. When multiplication occurs at a remote place, the incubation period is longer, as in hepatitis B.
- Rate of multiplication of the specific organism in the human host.
- Speed with which the host defense mechanisms are mobilized.

Considering the above factors, it can be easily understood why the incubation period of a disease is customarily described in terms of range (between the minimum and the maximum) and median. The median incubation period refers to the point in time when 50% cases have progressed to the stage of clinical manifestations.

As against incubation period, another term used very commonly is generation time. *Generation time* refers to the time interval between receipt of infection by the susceptible host and the stage of maximal infectivity of the host. The generation time may overlap either the clinical phase or the subclinical or inapparent phase. For example, the period of maximal infectivity in measles ranges from 4 days prior to appearance of rash to 5 days later.

Surveillance

Surveillance is collection and analysis of data for action. Analysis of surveillance data helps us to know time, place and person distribution of disease or other condition of ill health.

Types of Surveillance

Active surveillance: When a designated official usually external to the health facility visits periodically and seeks to collect data from individuals or register, log books, medical records at a facility to ensure that no reports or data are incomplete or missing. In National Vector Borne Disease Control Programme (NVBDCP), health worker goes out to the community for taking blood slide in malaria.

Passive surveillance: When data or reports are sent by designated health facilities or individuals on their own, periodically as a routine. In most of the national health programmes, data are selected by passive surveillance.

Sentinel surveillance: It is a method for identifying the missing case and there by supplementing the notified cases. Sentinel data are extrapolated to entire

Epidemiological Studies

OBJECTIVES OF AN EPIDEMIOLOGICAL STUDY

An epidemiological study is aimed at finding the following:

- Nature and extent of disease
- Causative agent
- Source of infection
- Period of communicability
- Mode of spread
- Susceptibility of population
- Incubation period
- Methods of prevention and control.

STEPS IN AN EPIDEMIOLOGICAL STUDY

- On first report, reach the place of occurrence of an epidemic and identify the cases on the basis of clinical and field evidence. Confirm the diagnosis by laboratory tests but start the control measures without waiting for the report.
- Prepare two proformas for investigation of the epidemic. In proforma A, record each case serially in a register having the following columns.
 - Serial number
 - Name
 - Age
 - Sex
 - Caste
 - Occupation
 - Social class
 - Locality
 - Household condition
 - Symptoms and signs
 - Immunity status
 - Contact during incubation period, and
 - Manner of getting the infection.

The source of water and milk supply and other details of specific situations may also be noted.

In proforma B, give daily, weekly or monthly report of each locality regarding the number of cases of the disease in the area. This proforma is compiled from proforma A and contains information regarding the following:

- i. Date of outbreak
 - ii. Date of last attack
 - iii. Attacks and deaths among vaccinated and unvaccinated persons
 - iv. Source of infection, and
 - v. Measures adopted.
- Progressive totals of various items in this proforma should also be given. Proforma B should be sent to the head office regularly, where the total information from the whole region is compiled and analyzed.
- Systematic investigation of each case is crucial for investigation of an epidemic. Since each case is a link

population to estimate the disease prevalence in total population. This is done in National AIDS Control Program (NACP).

Surveillance can be carried out as *Institutional Surveillance* or *Community Based Surveillance*. Institutional surveillance refers to the collection of data either active or passive from preidentified and designated fixed facilities regardless of size. Community based surveillance refers to the collection of data from individuals and households at the village or selected locality rather than from institutions or facilities.

Surveillance data allow for analysis, providing public health officials and policy makers with a basis for long-term priorities and timely information on possible outbreaks for rapid response (data for action). An increasing demand on detailed data and an ambition to present the data providers with more timely data for action were the driving forces behind the decision to use modern web technology and a geographical information system (GIS) software to improve the feedback of surveillance information.¹⁴

GEOGRAPHICAL INFORMATION SYSTEM (GIS)

GIS is a way to present data in the form of interactive web map. It can be defined as a set of tools for collecting, storing, retrieving, transforming and displaying spatial data from the real world for a particular set of purposes. Turning raw tabular data into much more useful and accessible visual information in the form of interactive Web maps is much needed to support and empower decision makers, and even members of the general public.¹⁴ There are different tools for producing GIS like GeoReveal, GéoClip and SVG (Scalable Vector Graphics) MapMaker.¹⁵ Wizard-driven tools like GeoReveal have made it very easy to transform complex raw data into valuable decision support information products (interactive Web maps) in very little time and without requiring much expertise. The resultant interactive maps have the potential of further supporting health planners and decision makers in their planning and management tasks by allowing them to graphically interrogate data, instantly spot trends, and make quick and effective visual comparisons of geographically differentiated phenomena between different geographical areas and over time (when data sets for successive periods of time are available).¹⁵

Geographic Information System (GIS), Remote Sensing (RS), Cartography, Photogrammetry and Geodesy are multiple disciplines known as Geomatics or geographic informatics. Geomatics will continue to provide considerable benefits through better informed policy making, planning and research. This is more important under the present situation of global climatic changes and re-emerging vector borne diseases.

in the chain of infection, full picture can be obtained either by investigating the first case and then proceeding forward to the next and subsequent cases, or by starting with the last case and then proceeding backwards. Either method may be used, depending upon the specific situation.

- Make a sample survey in a limited population to find the mild, missed or atypical cases and the carriers of disease, taking full benefit of the laboratory methods. The sample should be randomly selected and should be representative of the population.
- Make an ecological survey of:
 - Physical environment with particular reference to water supply, disposal of wastes and places of eating, such as hotels and restaurants.
 - Biological environments such as vectors and pet animals.
 - Socioeconomic environment as regards fairs, festivals, movement of pilgrims and common eating parties, etc.

The object is to find if the environment is playing a part as source of infection or vehicle for transmission of disease.

- Collect data, if any, about previous happenings or epidemic occurrence of the same nature.
- Look for any association of the disease with age, sex, socioeconomic status, profession, habits and customs, type of locality and water or milk supply. This can be done by preparing frequency distribution tables, histograms and spot maps which show the distribution of cases in relation to localities, restaurants and eating places, etc. and which mark the relevant environmental features such as water supply, waste disposal, vector density, etc.
- Analyze the data statistically. Find the incidence rates in relation to age, sex, locality, period and other characteristics. Work out the standard errors of observed differences. Formulate a hypothesis and draw conclusions on the basis of statistically significant differences as regards the role of agent, host and environment factors in the occurrence of the disease. Flea index, anopheles mosquito density, attack rates among the vaccinated and unvaccinated and high incidence in a particular community are some examples that may provide a clue to causative factors.
- Make appropriate recommendations for prevention, control or eradication of disease. For example, these recommendations may relate to improvement of water supply, food, disposal of wastes, sanitation, immunization, killing of vectors or eradication of reservoirs of infection.
- Test the hypothesis and the recommendations made by appropriate analytical or intervention studies.
- Publish the results of the investigation for wider benefit to the community.

Aim and Objectives of Epidemiology

Broadly speaking, the aim of epidemiology is to minimize or eradicate the disease or health problem and its consequences. In order to fulfill this, epidemiology has the following objectives:¹⁶

- To define the magnitude and occurrence of disease conditions in man
- To identify the etiological factors responsible for the above conditions
- To provide data necessary for planning, implementation and evaluation of programs aimed at preventing, controlling and treating disease.

Clinical vs Epidemiological Approach

The clinician and the epidemiologist are both concerned with patients and disease but their approach is different. The four main differences are outlined below:

1. A clinician studies the signs, symptoms, causes and treatment of disease in each individual even if he sees many cases of the same disease. An epidemiologist, on the other hand, studies the total number of cases, their distribution and the causes and modes of spread of disease in a community. He studies disease as a mass phenomenon.
2. A clinician is concerned only about the patient suffering from disease. On the other hand, an epidemiologist takes into account not only persons suffering from a disease but also those not suffering from it. He then tries to study the factors that prevented the occurrence of disease in nonsufferers. He analyzes distribution according to age, sex, race, class, environment, social customs, etc. and tries to account for the occurrence of a large number of cases in one group and not in the other. He makes a community diagnosis to provide community measures for prevention and control.
3. The clinician is usually more concerned about the period of pathogenesis during which the disease evolves and incapacitation results. To an epidemiologist, the period of prepathogenesis is more important than the period of pathogenesis.
4. Mere coming together of bacteria and man cannot produce disease. Disease develops only in a certain environment which also needs due attention. The clinician's concern about the environment is very limited. An epidemiologist studies in detail not only the host-parasite relationship but also the environmental aspects that bring about such relationship. Sound knowledge of clinical medicine is essential for the study of epidemiology. Clinical diagnosis of a case by the clinician should be supplemented by the total diagnosis or findings of the epidemiologist. They should be working together, one supplementing the work of the other. The epidemiologist requires very sharp and correct

observation in the clinic, ward, laboratory and in the field. He considers each case as the member of a family and the family as a unit of the society. To him, the patient is not an isolated entity as seen by the internist in a clinic.

Applications and Uses of Epidemiology¹⁷

The epidemiological methods are useful in studying the factors related to health, disease and health care services. Various applications and uses of epidemiology are described below:

TO STUDY THE OCCURRENCE OF DISEASE IN A POPULATION

It is very important to find the regional and secular (temporal) differences in disease prevalence. These differences may be natural or may be related to disease control measures. Morbidity surveys may be horizontal or vertical. A horizontal survey is a “breadthwise” or cross sectional survey, aimed at finding the occurrence of cases of a particular disease in a given geographical area such as a village, city, state or country. A vertical survey is a “depthwise” or longitudinal survey, aimed at finding the occurrence of a disease in a population over a period of time. An example is the death due to plague in India since independence (**Table 3.2**).

The above data, whose collection essentially involves epidemiological methods, clearly show the decline of plague in India during the period 1948 to 1970. It may be mentioned that resurgence of plague occurred in India in 1994 and 53 deaths occurred.

TO DIAGNOSE THE HEALTH OF THE COMMUNITY

The purpose of diagnosis is to take remedial measures. In case of an individual, therapeutic and preventive measure can be undertaken after diagnosing the morbid state. In case of a community, the study of not only morbidity but also mortality is useful to plan for prevention and treatment of the people. Such study is referred to as community diagnosis. *Community diagnosis* is defined as the pattern of disease in a community described in terms of the factors influencing

TABLE 3.2: Reported deaths from plague in India⁴

Year	No. of deaths
1948	23191
1950	18813
1952	3894
1954	705
1958	206
1962	200
1966	8
1970	NIL
1994	53

this pattern.¹⁸ The aim of community diagnosis is two-fold: *Firstly*, to identify and quantify the health problems in a community on the basis of morbidity, mortality rates and ratios and, *Secondly*, to identify the individuals or groups in the community who are at risk of developing the disease or who need health care.

An example of community diagnosis is given in **Table 3.3**, which shows the pattern of causes of mortality in Dadra and Nagar Haveli. It shows, for example, that diseases of digestive system and prematurity account for 41.2% and 11.8% deaths respectively. In order to present the community diagnosis in full, it would be necessary to describe the factors related to such deaths (e.g. water and sanitation situation in relation to gastrointestinal disease and MCH services in relation to prematurity).

TO IDENTIFY DETERMINANTS OF DISEASES

Etiology of disease is usually multiple. Epidemiology is of great help in studying the etiology and the associated risk factors. Examples are association between streptococcal sore throat and rheumatic heart disease; association between rubella and congenital defects; association between blood transfusion and hepatitis and that between smoking and lung cancer, as well as between tobacco chewing and oral cancer. Another example is the association between lack of dietary fiber and diseases like diverticulitis, colonic cancer, gallstone, etc. This association was established as a result of the epidemiologic studies of Burkitt.¹⁹ Another good example is that of pellagra. Its etiology was earlier disputed, being ascribed to diet by some and to infection by others. Epidemiologic observations indicated that while pellagra was common in inmates of asylums in USA and Italy, it was absent among the attendants. This fact was incompatible with an infective theory of pellagra but was readily explained by the different diets of patients and their attendants.

TO ESTIMATE INDIVIDUAL RISKS AND CHANCES

Epidemiological methods make it possible to state how much risk an individual has as regards developing a parti-

TABLE 3.3: Cause specific proportional mortality in 1985 in Dadra and Nagar Haveli⁴

Cause	Percentage of deaths
1. Diseases of digestive system	41.2
2. Senility	14.7
3. Fevers	11.8
4. Prematurity	11.8
5. Diseases of respiratory system	5.9
6. Diseases of circulatory system	5.9
7. Accidents	5.9
8. Others	2.9

Note: The above data are based upon study of a representative sample of 6025 out of a total population of 1,03,676.

cular disease or as regards outcome of disease. As an example, it has been calculated that the lifespan of an American male having 20 percent extra weight is 4 years shorter than his normal weight counterpart. Other examples are the risk of bearing a mongol child in relation to mother's age and the risk of developing lung cancer and coronary disease in relation to smoking. While the risk of bearing a mongol child is less than one in thousand for mothers below 30 years, it rises steeply thereafter to about 1 in 45 for mothers above 45 years of age.

TO PLAN HEALTH SERVICES

Health services—preventive, curative as well as rehabilitative—must be commensurate with the health problems in a region. Adequate epidemiological data base regarding the incidence and prevalence of various diseases and disabilities is essential for planning proper health services in a community. Examples are—health manpower planning, hospital planning (number of beds per thousand population for particular diseases) and planning of immunisation campaigns. Such planning is essential for preventing wastage of resources, minimizing costs and improving the effectiveness and acceptability of health services.

TO EVALUATE INTERVENTION MEASURES

New techniques and procedures are introduced from time to time to prevent or treat disease. Their usefulness and effectiveness needs to be demonstrated before their widespread use is recommended. Epidemiology is very helpful for this purpose. Examples are evaluation of BCG, hepatitis vaccine and newer antirabies vaccines in prevention of the respective diseases. From a wider perspective, epidemiological methods and data help in evaluating the health services and programs as such. An example is the evaluation of universal immunization program in India.

TO COMPLETE NATURAL HISTORY OF DISEASE

A physician sees only those patients who have active clinical disease and seek treatment. Slow growing diseases or those which remain asymptomatic for a long time may remain unidentified and their etiology may remain obscure unless they are studied using proper epidemiological methods. A classical example is the discovery of human slow growing viruses in the etiology of certain degenerative brain diseases.

TO FORECAST FUTURE DISEASE TRENDS

In a limited way, it may be possible to assess in advance the likely trends in incidence of certain disease on the basis of known epidemiological principles. Examples are cyclic occurrence of influenza and measles and change in occurrence of malaria due to change in climatic factors

such as rainfall. Such trend forecasts are currently being made in respect of AIDS.

TO IDENTIFY SYNDROMES

A syndrome refers to association of two or more medical phenomena. Syndromes can be identified when it is discovered through epidemiologic studies that apparently unrelated phenomena have the same cause. Examples are Plummer-Vinson syndrome (koilonychia and esophageal cancer) thiamine deficiency (Wernicke's encephalopathy, peripheral neuritis and wet beri-beri), and vitamin B₁₂ deficiency (anemia and subacute combined degeneration of spinal cord). Conversely epidemiologic investigations may reveal that what had been lumped together earlier as one syndrome or disease entity needs to be taken apart. An example is the distinction between gastric and duodenal ulcer, which was facilitated by the epidemiologic observation that the former is more common among poor people. Another example is Sydenham's uniform and consistent distinction of measles from other specific fevers. Other examples are distinction of gout from rheumatoid arthritis, gonorrhoea from syphilis and infective hepatitis (hepatitis A) from serum hepatitis (hepatitis B).

Frequency Measures

Three general measures are frequently used in epidemiology, i.e. ratios, proportions, and rates. Ratio is the most fundamental measurement in epidemiology using two variables, say x and y , and obtained by dividing one quantity by another without implying any specific relationship between numerator and denominator (expressed as x/y) such as number of still birth per 1000 live births. Ratio express a relation in size between these two quantities; the values of x and y may be completely independent, or x may be included in y . For example, the sex of patients attending an out-patient clinic could be compared in either of the following ways:

- *Male/Female*
- *All females/ Total*

In the first option, x (female) is completely independent of y (male). In the second, x (female) is included in y (all). Both examples are ratios.

A **proportion** is a ratio in which numerator (x) is included in denominator (y). Of the two ratios shown above, the first is not a proportion, because x is not a part of y . The second is a proportion, because x is part of y . This is ratio of a part to whole is expressed as percentage.

Rate, is often a proportion, with an added dimension of time: it measures the occurrence of an event in a population over time. The basic formula for a rate is as follows:

$$\text{Rate} = \frac{\text{Number of events or cases occurring during given period of time}}{\text{Population at risk during the same time period}} \times 10^n$$

Morbidity and Mortality Frequency Measures

To describe the presence of disease in a population, or the probability (risk) of its occurrence, following frequency measures may be used. **Tables 3.4 and 3.5** show a summary of the formulas for frequently used morbidity and mortality measures.

Secondary Attack Rate (SAR) and Attack Rate

A secondary attack rate is a measure of the frequency of new cases of a disease among the contacts of known cases. It indicates the propensity of disease transmission in population. To workout numbers of contacts (at risk), we usually subtract the number of primary cases from the total number of people.

Example:

Seven cases of diarrhea were reported among 60 residents of a hostel following a meal. Following

incubation of 24 hours further 10 cases occurred among the inmates of the hostel next day. We will calculate the attack rate and the secondary attack rate among contacts of those cases.

1. Attack rate in childcare center:

$x =$ No of primary cases of diarrhea = 30

$y =$ number of at risk population in hostel = 60

$$\text{Attack rate} = \frac{x}{y} \times 100 = \frac{30}{60} \times 100 = 50\%$$

2. Secondary attack rate:

$x =$ cases diarrhea among the contacts following primary cases was 10

$y =$ number of persons at risk (total number of members—resident already infected)

$= 60 - 30 = 30$

$$\text{Secondary attack rate} = \frac{x}{y} \times 100 = \frac{10}{30} \times 100 = 33\%$$

TABLE 3.4: Common measures of morbidity

Morbidity rates	Numerator	Denominator	Multiplier
Incidence rate	Number of new cases occurring during a given period of time interval	Average population at risk during same time interval	Varies: (10 ⁿ)*
Attack rate**	Number of new cases of a specified disease reported during a given period of time interval	Total population at risk, for a limited period of observation	Varies: (10 ⁿ)*
Secondary attack rate**	Number of new cases of a specified disease among contacts of known cases	Number of contract population at risk	Varies: (10 ⁿ)*
Point prevalence	Total number of current cases (new and old) of a specified disease existing at a given point in time	Estimated population at the same point in time	Varies: (10 ⁿ)*
Period prevalence	Total number of current cases (new and old) of a specified disease identified over a given time interval	Estimated population at mid-interval	Varies: (10 ⁿ)*

NB: *The value of n may be 1, 2, 3, 4, 5, 6

** These are special type of incidence rare

TABLE 3.5: Common measures of mortality

Mortality rates	Numerator	Denominator	Multiplier
Crude death rate	Total number of deaths reported during a given time interval	Estimated mid-interval population	1,000 or 100,000
Cause-specific death rate	Number of deaths assigned to a specific cause during a given time interval	Estimated mid-interval population	100,000
Proportional mortality	Number of deaths assigned to a specific cause during a given time interval	Total number of deaths from all causes during the same interval	100 or 1,000
Neonatal mortality rate	Number deaths under 28 days of age during a given time interval	Number of live births during the same time interval	1,000
Postneonatal mortality rate	Number of deaths from 28 days to, but not including, 1 year of age, during a given time interval	Number of live births during the same time interval	1,000
Infant mortality rate	Number of deaths under 1 year of age during a given time interval	Number of live births reported during the same time interval	1,000
Maternal mortality rate	Number of deaths assigned to pregnancy-related causes during a given time interval	Number of live births during the same time interval	100,000

PERSON-TIME RATE

A person-time rate is a type of incidence rate that directly incorporates time into the denominator. When a person or an event is observed for variable length of time we use person time as denominator for calculation of such rate. The denominator is the sum of the time each person is observed, totalled for all persons and numerator is still the number of new cases.

$$\text{Person-time rate} = \frac{\text{Number of cases during the period of observation}}{\text{Sum of time each person is observed (total person time)}} \times 10^n$$

Risk Ratio (Refer General Epidemiology—Chapter 4, Page 35)

A **risk ratio**, or **relative risk**, is the ratio of incidence of disease among exposed to risk factor and that among non-exposed to risk factor. It compares the risk of some health-related event such as disease or death in two groups. The groups may be differentiated by demographic factors such as sex (e.g. males versus females) or by exposure to a suspected risk factor (e.g. high fat vs low fat intake) or by other factors. A risk ratio of 1.0 indicates identical risk in the two groups.

$$RR = \frac{\text{Incidence of disease among exposed to risk factor}}{\text{Incidence of disease among non-exposed to risk factor}}$$

ATTRIBUTABLE RISK (AR)

It indicates excess risk of a disease that can be ascribed to exposure over and above that experience by non-exposed. It is also known as the 'Attributable Risk Percent'/Attributable Proportion or 'Risk Difference'. It is a measure of the public health impact of a causative factor and predict about the expected reduction in disease if the exposure could be removed (or never existed).

$$AR = \frac{\text{Incidence among exposed} - \text{Incidence among non-exposed}}{\text{Incidence among exposed}}$$

POPULATION ATTRIBUTABLE RISK

It is a measure of excess risk of disease in a population that can be solely attributed to a particular risk factor. It provides an estimate of the amount by which disease could be reduced in that population if the suspected risk factor is withdrawn.

$$PAR = \frac{\text{Incidence of the disease in total population} - \text{Incidence in non-exposed population}}{\text{Incidence of the disease in total population}}$$

Methodology of Epidemiological Studies

1. Definition of the problem, such as relationship of cancer and smoking.
2. Statement of existing facts by tabulating all available information as per age, sex, class, profession, habits and other characteristic features.
3. Formulation of hypothesis, such as smoking causes lung cancer.
4. Testing the hypothesis by making observations, trials or investigations to see if the hypothesis holds good.
5. Statistical analysis and drawing of logical conclusions.
6. Recommendations, if any.

It may be mentioned that four things are needed for carrying out a good field epidemiological study. These are a field unit, a statistical unit, a laboratory and an efficient transport system. The field unit consists of interrogators, technicians, enumerators, social workers, public health nurse, etc. with an epidemiologist as the head who should either be a good clinician himself or should have one in his team.

INTERNATIONAL CLASSIFICATION OF DISEASES

The essence of epidemiology lies in comparison of health and disease related data with reference to time, place and person. Comparisons can be meaningful only when different people understand a particular health term to mean the same thing all over the world. This is made possible through a system of "International Statistical Classification of Diseases and Related Health Problems."²⁰ This is briefly referred to as ICD-10, denoting that it is the tenth revision of the International Classification of Diseases. The first classification was published in 1893 as the Bertillon Classification of International List of Causes of Death. During last ten decades, there have been as many revisions. From Sixth Revision (1948) onward, the ICD has been coordinated by WHO. The ICD-10 came into effect on 1.1.1993. It is essential for all doctors to understand the concept of ICD-10, its role and its limitations.

BASIC STRUCTURE OF ICD

The ICD-10 differs from ICD-9 in that it uses an alphanumeric code instead of a purely numeric code. The basic or core code is a three character code, comprising a letter of the alphabet (excluding U) followed by two digits from 0-9. When finer classification is needed, a fourth character, a digit, is added after a decimal. Letter U is reserved for provisional classification of new diseases of uncertain etiology.

The total ICD-10 is divided into 21 Chapters, each chapter having a few blocks of disease categories. For example, chapter 1 is titled "Certain infectious and parasitic diseases". It covers entries from A00 to B99 spread over 21 blocks. The block for viral hepatitis (B+15 to B19) has the following three character categories:

B 15	Acute hepatitis A
B 16	Acute hepatitis B
B 17	Other acute viral hepatitis
B 18	Chronic viral hepatitis
B 19	Unspecified viral hepatitis

Under B 15 acute hepatitis A are listed 2 four character categories:

B 15.0	Hepatitis A with hepatic coma
B 15.9	Hepatitis A without hepatic coma

A list of the 21 Chapters in ICD-10 along with the number of categories in each chapter is given below.

CLIMATE EPIDEMIOLOGY

Human beings are directly exposed to various forms of changes in climate including temperature, extreme events like cyclone, heat waves, sea level rise, etc. The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) has stated the contribution of climate change on the global burden of diseases and premature deaths.²¹ Climate epidemiology will provide more accurate estimations of disease burden, vulnerability, forecasting and adaptation capacity, which would help in appropriate resource allocation for all preventive measures.

SOME PUBLIC HEALTH SOFTWARE

Health map: Created by joint WHO/UNICEF program to establish a GIS in Guinea worm eradication program, now it has been expanded to other public health applications.

Health mapper: It simplifies collection, storage, retrieval and analysis of public health data to support planning and decision-making both at macro and microlevel.

Epi map: Data are displayed by geographic or other maps.

Epi analyst: Used in epidemiological research.

Epi info: It can be used for data entry and analysis; in addition it is used to develop a questionnaire.

Statistical package for social sciences (SPSS): It is a comprehensive system for analyzing data. SPSS can take data from almost any type of file and use them to generate tabulated reports, charts and plots of distributions and trends, descriptive statistics, and complex statistical analyzes. Different versions of this software are available.

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4

General Epidemiology

Diseases have afflicted mankind since days of yore. Alterations in growth, disturbances of metabolism, degenerative changes with advancing years, accidents, poisons, tumors, cancers, and invasions of body by microorganisms, all seem to have occurred with varying extent and distribution with the changing environment in which man has lived.¹

Epidemiology has been recognized as “the multi-disciplinary study of the distribution (person, place, time) and determinants (cause) of health-related states or events in specified populations and the applications of this study to control of those health problems”.²⁻⁴ Epidemiology has evolved over a few centuries. It has borrowed from sociology, demography, statistics, as well as other fields of study and it is still considered as neonate or budding science.⁵ It was not until the 19th century that the fabric of epidemiology was finally woven into a distinct discipline with its own philosophy, concepts and methods.⁶ Epidemiological principles and knowledge of distribution of disease may be utilized to describe the natural history of disease as well causal factors.⁷ Thus, it is useful to know how the duration of a disease and the probability of the various possible outcomes (recovery, complication, death) vary by age, gender, and so on. Such knowledge is useful not only for prognostic purposes but also in advancing hypotheses as to what specific factors may be more directly involved in determining the course of disease in an individual.⁸

Epidemiology is the basic science of public health that deals with health and disease in population. It has been defined various way by different epidemiologist.

Definition

‘Study of the distribution and determinants of health related states or event in a specified population and application of this study to the control of health problems’ (Jhon M Last, 1988). Last’s in his definition emphasized that epidemiological study is not only concerned with the disease but also with ‘health related events’. The term ‘epi’ means among and ‘demos’ means people; any study undertaken among population to find the magnitude of health problems and their distribution,

causes with a aim to suggest remedial measures for those problems are called epidemiology. The word ‘study’ denotes scientific inquiry on some problem or event. The epidemiological investigation to health problem involves following *two basic approaches*.

1. Asking questions: Availability of data is prerequisite for any systematic investigation on health problem in population; key information can be approached through a series of questions:

- What is the health problem, condition, what are its manifestation and characteristics?
- Who are affected, with reference to with age, sex, social class, etc.?
- Where does the problem occur, in relation to geographical distribution, residence, place of exposure, etc.?
- When does it happen in terms of day, months, seasons, etc.?
- Why does it occur, in terms of the contributing or causative factors?
- So what can be done? What intervention may have been implemented? Have there been any improvement following any action?

2. Making comparisons: The next basic approach is to make comparison and draw inference. Such comparison may be made between different population at a given time, between subgroup of population, or between various periods of observation. By making comparisons, the investigator attempt to find out the difference related to study variables among study and comparison group, which help to draw inference on contributing factor or etiology of a disease. To ensure the ‘comparability’ between the groups (i.e. study group and control group), both the groups should be as similar as possible to all factors that may relate to the disease except to the variable under the investigation. In other word we can say that ‘the like can be compared with like’.

Types of Epidemiological Study

Epidemiological studies can be broadly classified as observational and experimental study with further subdivision, however, these studies cannot be regarded

as watertight compartment; they complement one another.

Observational study

- Descriptive—it includes case report, case series, correlation/ecological study, cross-sectional/prevalence studies.
- Analytical—can be of following type
 - Group based—the unit of study is population as group, e.g. ecological study
 - Individual based
 - i. Cross-sectional
 - ii. Retrospective—this can be case control study
 - iii. Prospective—this is cohort study, also called follow-up study

Experimental Study (Interventional study)

Experimental study (Interventional study)—include clinical trial, field trial, etc.

OBSERVATIONAL STUDY

In this study nature is allowed to take its own course, investigator only measure do not intervene or manipulate any variable. This includes descriptive and analytical epidemiology. The descriptive epidemiology is concerned with measuring frequency and study of distribution of health related problem in population whereas analytical epidemiology attempts to analyze the cause or determinants of disease (how the disease caused?) by testing the hypothesis that has been set out in the study.

EXPERIMENTAL STUDY (INTERVENTIONAL STUDY)

Unlike the observational study, the researcher in an experimental epidemiological study, control or manipulate one or more factors in the study to obtain information how the factors influence the variables in the study and draw inference. This manipulation may be deliberate application or withdrawal of suspect causal factor or changing one variable in the experimental group while making no change in the control group and comparing the outcome in both groups. The experiments are designed to test the cause effect hypothesis.

EVALUATIVE STUDY

Evaluative study are those that appraise the value of health care; they are set out to measure the effectiveness of different health services. They are of two main types: review and trials.

Types of Evaluative study

- Program review
- Trials
 - Clinical trials

- Program trial
- Trial of screening and diagnostic tests

Study Design

Structuring of research design can be divided into observational and experimental type. Observational types of studies generally employ the method of sample surveys, where a sample of the population is observed for various characteristics, whereas surveys where the observations on cause and effect differ by way of a period of time (such as case-control studies and cohort studies) are considered to be analytical in nature, and inference of associations can be made.

Study design may be classified into different type according to time of measurement of specific factor (cause) and its effects (disease).

Cross-sectional

A survey or study that examines people in a defined population at one point of time. Cross-sectional study may be descriptive, analytical, or both. Descriptive cross-sectional survey usually provides prevalence data but repeated survey can be used to give an estimate of incidence. In cross-sectional surveys the information on cause and effect is simultaneously gathered and the time sequence cannot be determined (e.g. study of relationship between body built and hypertension). Hypothesis may be generated from this type studies. This approach is useful during investigation of epidemic. This cannot distinguish whether exposure preceded the development of a disease or presence of a disease affect the individual's level of exposure. From epidemiological study it has been noted that individuals with cancer have significantly lower level of B-carotene in blood but from the study it is not possible to comment, which is the cause and effect. It is to be noted that in cross-sectional design observations are made *at one point of time only*.

Longitudinal study design: In contrast to previous designed described there is another type called longitudinal study design. In this design the observations or data refer to for more than one point of time. The difference between cross-sectional surveys and longitudinal studies can be expressed similar to difference between snapshot and motion picture.

Retrospective (Backward Looking Study)

Here the investigator start with effect and goes back to find the cause.

Prospective (Forward Looking)

In this study the investigator start with causative factor and goes forward to the effect. The term prospective not necessarily mean that the study is carried out in

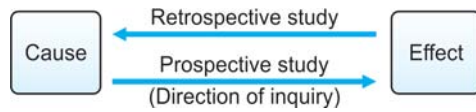


Fig. 4.1: Schematic presentation of prospective and retrospective study design

future, it can be carried out based on findings on record in past. Study population are divided into two groups, exposed to the factor of interest and not exposed to that factor, and then followed up to see and compare the development of disease in these two groups.

'Retrospective' and 'prospective' are distinguished by temporal relationship between initiation of study and the occurrence of disease outcome being studied. If the *outcome* and *exposure* both have already occurred at the initiation of investigation called retrospective (it can be case-control study or retrospective cohort study) and if the outcome of interest has not occurred at the initiation of investigation called prospective (also called cohort study) (**Fig. 4.1**).

Choice of Study Design

A particular research question may be addressed using different epidemiological approach; the choice depend upon nature of the disease, type of exposure and availability of resources, as well as result from previous studies and gap in knowledge. The descriptive studies are primarily carried out for measuring frequency and describing pattern of disease or health related problem and for formulation of etiological hypothesis. On the other hand both case-control and cohort study can be used to test a hypothesis. For rare disease a case control study design is useful and for common diseases cohort study is suitable (large no of subjects available and need follow-up to get sufficient number of case).

Descriptive Epidemiology

The distinctive feature of this approach is that its primary concern is with description rather than with the testing of hypotheses or proving causality. This study is concerned with disease *distribution* and *frequency* in human population in relation to time, place and persons and identifies the characteristics with which the disease in the question is related. In this study the investigator tries to get the answer of questions about a disease or health related events. What is the problem and its frequency? Who are affected (person distribution)? When the disease occurs (time distribution)? Where (place distribution)? Descriptive studies are useful to formulate hypothesis.

Distribution is concerned with finding the frequency and pattern of disease or health related events in a population. Rate (number of events divided by size of the population) may be used to measure frequency,

which allows valid comparisons across different populations. Pattern refers to the occurrence of health-related events by time, place, and personal characteristics. Sometimes we can study association between variables, which help in formulation of hypothesis.

MEASURING FREQUENCIES

The two main measures of frequency of disease, health problems and utilization of health services are incidence and prevalence. Incidence and prevalence may be expressed in absolute number or rate.

TIME TREND

These explain time distribution of occurrence of disease or health related events.

Secular Trend (Long-term)

Variation that occur over period of years, e.g. incidence of diphtheria showing decrease trend and diabetes, CHD, cancer showing rising trend since last few decade.

Periodic Trend (Cyclical Fluctuation)

Periodic fluctuation in occurrence of diseases is known as periodic trend, e.g. upsurge in influenza activity every 2 to 3 years result from antigenic drift of virus. Cause of periodic variation: (a) Variation in herd immunity, (b) Antigenic variation in agent.

Seasonal Trend

Annual variation in the disease incidence that is related in part to a season is called seasonal trend, e.g. community acquired infections and nosocomial infections show increased incidence in winter months because people inhale closed unfiltered air with droplet nuclei.

Acute (Epidemic) Trend

Short-term fluctuation is seen with epidemic outbreak. Epidemic is portrayed by epidemic curve, which is a graphical presentation of number of cases plotted against time.

PLACE DISTRIBUTION

World is not uniform in its characteristics, it varies in culture, standard of living, genetic makeup, etc.

Relative importance of these factors in etiology of a disease can be studied due to difference in place distribution, e.g. migration study can distinguish genetic and environmental factor in disease aetiology. To analyze by place, we usually organize data into a table, a map, or both. Variation may be classified under various levels.

International Variation

Stomach cancer is highest and breast malignancy is lowest in Japan, oropharyngeal cancer is high in India in comparison to other part of world.

National variation

Disease variation is also noted within the country.

Rural-Urban variation

Ch. bronchitis, mental illness, accidents, CHD are more common in urban area.

Local Variation

Geographical variation can best studied with aid of 'Spot map/ Shade map' which at a glance can show high or low frequency of a case. Clustering of cases may suggest common risk factors shared by all. Spot map used in 'John Snow cholera epidemic investigation' showed a common water pump in the Broad Street was source of infection thus helped to hypothesized that 'cholera is an water born disease'.

Person Distribution

Disease or a health related event is described by personal characteristics like demographic factors (e.g. age, race, sex, marital status), socioeconomic status, behaviors, environmental exposures, etc.

TYPES OF DESCRIPTIVE STUDY

- *Case series*: This kind of study is based on reports of a series of cases with no specifically allocated control group.
- Community diagnosis or needs assessment.
- Epidemiological description of disease occurrence.
- Descriptive cross-sectional studies or community surveys ('prevalence' study)
- *Ecological descriptive studies*: When the unit of observation is an aggregate (e.g. family, clan or school) or an ecological unit (a village, town or country) the study becomes an ecological descriptive study.

CASE REPORTS AND CASE SERIES

Case report is the descriptive study of the individual in terms of a careful, detailed report of a single patient. Case series means characteristics of a number of patients with a given disease. In other words, case series are the collection of individual case reports, which may occur within a fairly short period of time. These studies lead to formulation of new hypothesis.

Advantages

- New diseases are recognized, for example: Acquired Immunodeficiency Syndrome (AIDS), 5 cases of *Pneumocystis carinii* pneumonia

- Formulation of new hypothesis concerning possible risk factors.

Disadvantages

- Case reports are based on experience of only one person
- Cannot be used to test the presence of valid association
- Presence of risk factors may be purely coincidental and hence unreliable.

The planning phase of a descriptive cross-sectional study:

The following steps should be followed in conducting a descriptive epidemiological survey:

- Formulation of study objectives
- Planning of methods
 - Study population
 - Variables
 - Methods of data collection
- Methods of recording and processing data
- Comparing with known indices.

Objectives of a Descriptive Study

In formulating the objectives, the researcher expresses what he wishes the study to yield. The researcher may investigate the characteristics of population or obtain information on health status and health service (e.g. to find out incidence, prevalence, case fatality rate, distribution of some events, etc); and sometimes may find the association between variables, which help in formulation of hypothesis (e.g. the incidence of disease may be measured by time, place, person). Objectives should be expressed in specific and measurable term. The more specific the objectives the more easy it is to generate reliable and valid data.

The Study Population

Definition, sampling and sizing: This is the individual unit of study (persons, families, medical records, specimens, etc). It should be clearly and explicitly defined in terms of age, sex, occupation and other relevant criteria. The procedures for finding and inclusion of subjects (e.g. volunteers, hospital populations, people in the community) in the study should be clearly mentioned. The whole of the population in a geographical area or a representative part of it (sample) may be taken as study population.

Variables: Selection, Operational Definition and Measurement

The characteristics that are measured referred to as variables, which may be measured numerically (e.g. weight, height) or in terms of category (e.g. sex, presence or absence of a disease). Each of the variables used in the study should be clearly and explicitly defined. There are two kind of definition—conceptual

and operational. The conceptual definition defines the variables as we conceive it where as the *operational definition* ('working definition') define the characteristic as we actually measure it. An example of operational definition of obesity: A weight, in under clothes without shoes which exceeds by 10% or more of standard weight for age, sex and height in a specified population.

The disease under the study should be defined by a set of standard criteria called '*Case Definition*'. By using a standard case definition we ensure that every case is diagnosed in the same way, regardless of when or where it occurred, or who identified it. A case definition consists of clinical criteria and sometimes specified by limitations on time, place, and person. The clinical criteria usually include confirmatory laboratory tests, if available, or combinations of symptoms (subjective complaints), signs (objective physical findings), and other findings. For example, 'Clinical measles' may be defined as follows:

- Any person with fever and maculopapular rash (i.e. non-vesicular or without fluid), with cough or coryza (running nose) or conjunctivitis (red eyes).
- The variables under the study should be measured and *described by time, place and person* (described in earlier section).

Methods of collection, recording, processing and analysis of data should be planned before starting the study.

Comparing with Known Indices

By making comparisons, the investigator attempt to find out the difference related to study variables, which help to draw inference on contributing factor or etiology of a disease.

Determinants means to search for causes and other factors that influence the occurrence of health-related events.

Analytical (Explanatory Study): This study aims to explain a situation, i.e. to study the determinative processes of a disease or event. This tries to analyze the relationship between health status and other variable. Why does the disease occur in these people? Why certain people fail to make use of health services? Can decrease incidence of a

disease be attributed to preventive measures? Analytical study may be group based or individual based. In the group based study the researcher attempt to compare the data related to a variable in a group of population. For example, correlation study, a type of analytical study uses data from group of population as unit to compare the disease frequency among different group, e.g. per capita consumption of meat and rate of colonic cancer among population of different countries showed positive correlation. This type of study cannot test the hypothesis as they refer to group of population rather than to individuals. Individual based analytical studies though undertake survey of groups but they utilize information about each individual in the group. Two most important study designs under this category are **Case-control study or Cohort study (Table 4.1)**.

Case control study: In this study an investigator starts with diseased subjects and look back to study the exposure to the suspected factor. The diseased subjects taken for the study are called cases and another group without disease called comparison group are taken to compare the rate of exposure to the suspected factor in these two categories (**Fig. 4.2**).

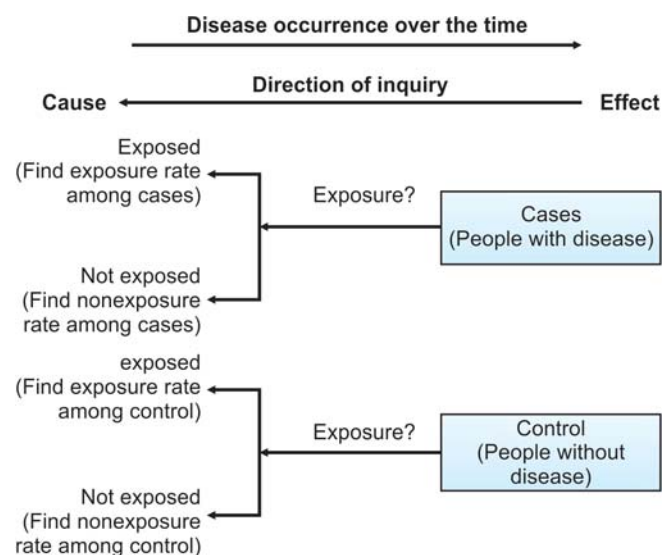


Fig. 4.2: Case control study design (Effect to cause study)

TABLE 4.1: Strength, weakness and main difference between case control cohort study

Case control	Cohort
<ul style="list-style-type: none"> • Proceed from effect to cause • Start with diseased population • Case control provide information about one outcome only 	<ul style="list-style-type: none"> • Proceed from cause to effect • Start with people exposed to the factor under study • Useful for evaluating more than one outcome related to single exposure
<ul style="list-style-type: none"> • Allow to study the range of exposure • Suitable for study of a rare disease • For rare exposure study, case control may not suitable one • Cannot estimate the incidence of a disease, so only can give estimate of relative risk (odd's ratio) • Time, cost, involvement is more • No problem of drop-out but record based information may be a problem 	<ul style="list-style-type: none"> • Usually focus on one exposure only • Impractical to consider cohort study for rare diseases • Suitable for rare special exposure study • Can provide accurate estimate of incidence of a disease—possible to find RR and attributable risk • Time, cost, involvement is more, more • Being a follow-up study there is more chance of drop-out

Features of a case control study:

- Both exposure and outcome have occurred before the beginning of the study.
- Proceeds from effect to cause.
- Use a control or comparison group to support or refute an inference.

Steps of case control study:

- Statement of the hypothesis
- Selection of cases and control
- Matching between cases and controls
- Measurement of exposure
- Analysis and interpretation.

STATEMENT OF THE HYPOTHESIS

This should be based on hypothesis which has been formulated from previous descriptive study or from previous experience.

Selection of Cases and Control

Defining the cases: The cases should be defined beforehand to avoid bias in the study. Diagnostic criteria and eligibility criteria should be established for cases.

Sources of cases: The cases can be taken from hospital or community.

Selection of control: The controls should be similar to cases as much as possible in respect of different variables except for presence or absence of the disease under study. Controls are not needed in the study in which hypotheses are not tested. Selection of controls depends on the nature of study. In a retrospective survey the association between a postulated cause and disease, the study group is compared with control group. Control should be selected from same source population from which the cases have been taken. Control should be representative of source with respect to exposure. Time during which a subject is eligible to become a control should be same in which an individual become a case.

Source of control: The controls can be taken from hospital, relatives, neighbours or general population.

Control from hospital or clinic: In a case control study, the controls can be selected from the patients with other disease (other than the disease under study) from same *hospital or clinic*. In this type of control selection, the study and control population are similar at least to some extent as they are from same parent population (catchments), and are subject to same selective factor. However, the selected control group being ill may not be representative of person without the disease under study.

Population control: If the cases are representative sample of a defined population and controls are sampled directly from that population, a random sampling of control may be a suitable one. If a population register exist or can be compiled this may

be desirable method of control selection.

Size of control: Ideally case control ratio should be 1:1, but when there is doubt regarding the matching of all variables, several controls may be taken to increase comparability (e.g. 1:4). Any specific deficiency in matching can be compensated by inclusion of another group and thus will increase the power of test.

Neighborhood control: Where source population cannot be enumerated, instead of going through random sampling control match, the investigator may take control people who reside in the same neighborhood.

Matching between Cases and Controls

The controls should be similar to cases as much as possible in respect of different variables and matching can ensure this. Matching can be done various ways:

Individual matching: Each control may be so selected that he or she should be similar to the study subject in respect of different variables. This type one to one control can be taken from spouse, sibling, friends, neighbor, fellow worker, etc. This one to one close matching may not be possible if we wish to control more than two or three variables simultaneously.

Group or stratified matching: If control is taken as group and matching is done with study group for different variable like age, sex, occupation, etc. called group matching.

A combination of above may be used. Whatever method is used for selection of controls, clear cut rules should be laid down to ensure objectivity. For example, in individual matching, the degree of similarity must be expressed clearly for each characteristic.

Measurement of exposure: Measurement criteria must be defined clearly and same criteria should be used for measuring variables among the cases and controls.

Analysis and interpretation: A variety of statistical test are available some commonly used test are described below:

Frequency distribution of all variables: It is advisable to start the analysis by examining the frequency distribution of variables.

Summary of frequency distribution: Summary statistics of frequency distribution such as mean percentage, rate, of relevant variables can be calculated.

Association between variables: Analysis is done by finding and comparing the rates of exposure to a suspected factor among cases and controls. Simple methods of cross tabulation with a pair of variable may reveal association. Basic analytic framework for a case control study is 2×2 (**Table 4.2**). For example if the intension is to test the hypothesis that 'cigarette smoking

causes lung cancer', the investigator begin with lung cancer cases (a+c) and matched control (b+d) to find out if there is any difference in exposure to a risk factor. This difference can be found out by statistical test of significance.

Calculation of Odds ratio: Since the typical case control donot provide incidence rate of disease in exposed and nonexposed group we donot get true measurement of relative risk from this study; instead we use the odds ratio as a measure of estimation of disease risk associated with exposures. The odds ratio is sometimes called the **cross-product ratio**, because the numerator is the product of cell a and cell d, while the denominator is the product of cell b and cell c (**Table 4.2**). The odds ratio is calculated as:

$$\text{Odds ratio} = ad/bc$$

TABLE 4.2: A case control study of smoking and lung cancer with hypothetical data

Exposure	Cases (lung cancer)	Control (without lung cancer)
Smokers	a (95)	b (70)
Nonsmokers	c (5)	d (30)
Total	a+c (100)	b+d (100)

Exposure rate:

- Cases = $a/(a+c) = 95/100=95.0\%$
- Control = $b/(b+d) = 70/100=70.0\%$

Test of significance for the difference noted in exposure rate: p value < 0.001

Estimation of risk by Odds ratio: $ad/bc = 2850/350=8.14$.

COHORT STUDY (FOLLOW-UP STUDY)

It is an observational analytical study in which individuals are identified on the basis of presence or absence of exposure to a suspected risk factor for a disease and followed over time to determine the occurrence of subsequent outcome. This is also called 'cause to effect study' as the outcome of interest has not occurred at the initiation of investigation (**Fig. 4.3**). It has the advantage of establishing the temporal relationship between exposure and health outcome, and thus they measure the risk directly. The Framingham study is a well-known cohort study which has followed over 5,000 residents of Framingham, Massachusetts, since the early 1950's to establish the rates and risk factors for heart disease.⁹

Features of a Cohort Study

- Exposure has started or yet to start but outcome has not yet occurred. However, in retrospective cohort

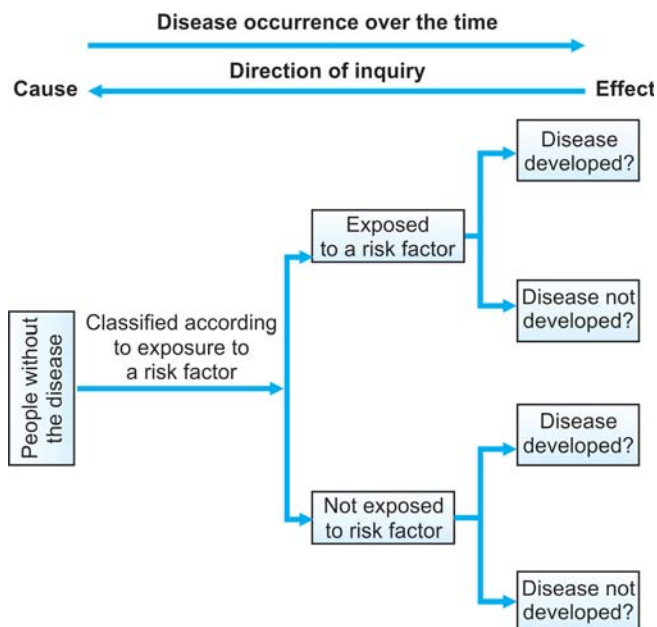


Fig. 4.3: Cohort study design (Cause to effect study)

study both have occurred, but investigation is designed to proceed from cause to effect.

- Proceeds from cause to effect.
- Use a nonexposed group to support or refute an inference.

Cohort: A well-defined group of people who share some common characteristic or experience called cohort. A group of people born during a particular year is called birth cohort, a cohort of smokers has the experience of smoking in common. There are two cohorts in cohort study, one of them is described as exposed cohort (exposed to the putative cause or condition) and other is unexposed or reference cohort (not exposed to the putative cause or condition). There may be more than two cohorts when exposure is classified according to level or type of exposure.

Indication: When exposures are uncommon but incidence of disease among the exposed group is comparatively high then cohort study may be suitable one (e.g. radiation exposure).

Type of Cohort Study

Depending upon the temporal relationship between the initiation of the study and the occurrence of the outcome (e.g. disease) the study can be classified under following heading.

- **Prospective cohort study:** The study subjects are classified on the basis of presence or absence of exposure and followed up to find the development of the outcome of interest. In this type, exposure may or may not have occurred but outcome must not have occurred at the beginning of the study.

- **Retrospective (historical) cohort study:** The subjects are also classified on the basis of presence or absence of exposure but in this type both the exposure and the outcome of interest have already occurred at the beginning of the study. A historical cohort study depends upon the availability of good data or records that allow reconstruction of the exposure of cohorts to a suspected risk factor and follow-up of their outcome (e.g. mortality or morbidity) over time. The study can be carried out quickly and with limited resources.
- Combined cohort study having both retrospective and prospective design.
- Inserting case control with cohort study (nested case control).

Methodology (Steps) of Cohort Study

- Selection of study subject
- Selection of comparison group
- Obtaining information on exposure
- Follow-up
- Analysis and interpretation.

SELECTION OF STUDY SUBJECT

Initially the members of cohort must be free from the disease under study. The study subjects may be drawn from:

GENERAL POPULATION

The study subjects are chosen from general population (not a special exposure group). Subsequently they are divided into two groups described as exposed cohort and unexposed or reference cohort. Both the group should be representative of corresponding segment of general population. Relatively common exposure such as smoking, coffee drinking a large number of exposed subjects could be identified from general population. Famous 'Framingham heart study' selected study cohort from the resident of Massachusetts and followed them for 30 years.

SPECIAL GROUP

For rare exposure, such as related to a particular occupation, or environmental condition in a specific geographical location, it is more efficient to choose cohort from special group, e.g. doctors, nurses, occupational group, special exposure group, etc. It gives sufficient number of exposure population within reasonable time. For example, to study the relationship between industrial solvent and carcinoma, a retrospective cohort can be selected from particular occupation group.

Selection of Comparison Group

The comparison group (unexposed or reference cohort) should be as similar as possible to exposed cohort with respect to all factors that may relate to the disease except to the variable under the investigation. Comparison group is required to compare the difference in the rate of disease occurrence among two groups. There are various ways of selecting the comparison group. The controls can be taken from hospital, relatives, neighbors or general population.

Internal comparison: A single general cohort is entered in the study then its members are classified into different exposure groups on the basis of information obtained before the development of disease. The cohort study undertaken by Doll and Hill (1950) classified British physicians into smokers and nonsmokers group which acted as an internal comparison.

External comparison: In a cohort study of special exposure group it may not be possible to identify a portion of cohort that can be assumed to be nonexposed to the suspected risk factor for comparison. In such situation an external comparison group can be taken from general population or any other special exposure cohort, which is similar with study cohort. A cohort of radiologist can be compared with cohort of ophthalmologist to investigate the effect of radiation on development of malignancy.

Comparison with general population rate: Disease experience of study cohort can be compared with that of general population, e.g. lung cancer mortality of uranium mineworkers can be compared with that of general population.

Obtaining information on exposure: The goal is to obtain complete, comparable and unbiased information. Exposure information should be collected in such a manner that the study group can be classified according to degree of exposure. Information about the exposure may be obtained from number of sources.

- From cohort members by interview or mailed questionnaire.
- Review of available records.
- Medical examination or special test.
- Other sources.

Follow-up: At the beginning of the study, method should be developed to obtain data for assessing the outcome. The entire study participant should be followed up from point of exposure.

Analysis: The basic analysis of data from a cohort study involves the calculation of incidence rate of a specified outcome among both the group and estimation of risk. The rates can be compared among various groups with different degree or grade of exposure. The common measurement of analysis are following:

Measures (Refer Basic Measurement in Epidemiology in Chapter 3)

- Relative risk (true measurement of risk)
- Attributable risk (measurement of potential impact)
- Population attributable risk (measure of impact in population).

Relative risk (RR): It estimates the magnitude of association between exposure and disease. It indicates the likelihood of developing the disease in the exposed group relative to the unexposed group. It is a ratio of the incidence of the disease among the exposed persons to that in the unexposed persons:

$RR = \frac{\text{Incidence of disease among exposed persons}}{\text{Incidence of disease among nonexposed persons}}$

To calculate RR, a 2 by 2 table has to be made. The pattern of the table is exactly the same as that given in reference to the Odds Ratio. Exposure to the risk is shown in rows (horizontal) and presence or absence of disease is shown in columns (vertical).

Example: A cohort study is conducted to investigate the effect of smoking habits on lung cancer. It is found that among 200 smokers, 140 developed lung cancer while among 200 non-smokers 70 developed lung cancer. The following results were found:

Exposure Smoking Habit	Lung Cancer Present	Lung Cancer Absent	Total
Smokers (Exposed)	140 (a)	60 (b)	n1=200
Nonsmokers (Nonexposed)	70 (c)	130 (d)	n2=200
Total	210	190	400

From the table, it can be seen that the incidence of lung cancer over the total time period of the study among the exposed people is $140/200 = 0.70$ or 70 percent. The incidence among the non-exposed persons is $70/200$ or 0.35 or 35 percent. The relative risk is therefore $0.7/0.35 = 2.0$

This is interpreted, as “people who smoked cigarettes were 2 times more likely to develop lung cancer than the nonsmokers”.

Evaluative Study

In **evaluative study** some form of value judgements may be required. Attempt should be made to reduce the subjective element in judgment by using explicit criteria in assessment. Basic questions that are addressed in evaluative study provide the framework for setting study objectives. Following are the basic questions of an evaluative study:

- **Requisiteness (appropriateness) of care:** To what extent is the care needed?
 - Degree of need as judged by professionals
 - Need can be assessed from relative importance of problem, extent and severity of problem, perceived need (expressed by public), expressed demand (utilization of services)

- **Quality:** Quality of care need to judge on following aspect:
 - Structure evaluation (about facilities and settings)
 - Process evaluation (regarding performance of activities)
- **An appraisal of the performance of services indicate:**
 - What kind of services and how much?
 - Coverage of services, utilization of services, degree of compliance, community participation, etc.
 - Outcome evaluation (regarding the effect).

Appraisal of outcome requires clear-cut criteria of effectiveness. Effectiveness is the extent of achievement of pre-established target or goal attained as result of activities. If pre-established target or goal cannot be used as criteria, the investigator will need to formulate suitable criteria.
- **Efficiency (Economic efficiency):** Unit cost analysis, cost effective ration, cost benefit ratio
- **Satisfaction:** Client satisfaction and job satisfactions
 - Require attitudinal survey
 - Not necessarily means high quality services
 - Satisfaction ensure compliance.

USES OF EPIDEMIOLOGY

Refer Chapter 3 Page 22.

Some Example of Well-known Epidemiological Study

John Snow's classic study on cholera epidemic:

John Snow is called the father of field epidemiology. Conducted his classic study on cholera in 1854 in the Golden Square of London. Snow believed that water was a source of infection for cholera (hypothesized). He began his investigation by marking the location of water pumps source for human consumption in the locality and then looked for a relationship between the distribution of cholera case households and the location of pumps. He noticed large number of cases in Broad Street area and then used this information to map the distribution of cases on what epidemiologists call a spot map; he observed the clustering of cases around a particular water sources (Broad Street pump). He also gathered information on water consumption in other area and noticed few number of cholera cases where the resident obtained water from alternate source. Consumption of water from the Broad Street pump was the one common factor among the cholera patients and concluded that the Broad Street pump was the most likely source of infection. Snow removed the handle of the Broad Street pump and aborted the outbreak.

Search for Cause and Risk Factors

Retinopathy of prematurity (ROP): In 1942, Terry first described the presence of grayish white opaque membrane behind the lens in premature babies known as ‘retrolental fibroplasia’ or (ROP), the cause of which

was not known at that time. Epidemiology of disease revealed peculiar clustering of ROP in a neonatal unit, where paradoxically the premature infants' survival rate had been improving. Based on preliminary observation, a well-controlled multicentric trial concluded that uncontrolled oxygen as toxic to premature retina. Following that liberal oxygen use was discontinued in premature infants.¹⁰

Diethyl stilbesterol (DES) and vaginal carcinoma:

Over a period of four years a physician diagnosed clear cell Ca of vagina in seven young girls aged 15 to 22 years in a hospital of Boston in the year 1977. This disease had never been reported before in this age group. The apparent clustering of cases, led these worker to design a case control study and result proved that the use of DES during pregnancy was associated with occurrence of vaginal carcinoma in their offspring.¹⁰

Assessing the impact of legislative policy or law.¹⁰

Epidemiological research can help to assess the influence of legislative policy or law on health of public at large. The effect of government law could be positive, in such situation epidemiological study can provide scientific basis to support the law. On other hand if the law is inflexible or harmful, epidemiology can provide scientific basis to revert the policy or law in question. Example of some research that proved to be beneficial is as follows:

- Labor law to protect worker from occupational hazards
- Mandatory seat belt policy
- Antismoking policy.

Experimental Studies

An experimental study is a most definitive tool for evaluation of clinical research. It is a gold standard for evaluating effectiveness as well as side effects of therapeutic, preventive and other measures in clinical medicine as well as in public health.

An experimental study is defined as a study comparing the effect and value of intervention(s) against a control in a group of subjects. The basic difference between observational and experimental study is the intervention (manipulation).¹¹ It may be mentioned that Phase-I and Phase-II trials during development of a new drug are often conducted without a control group but Phase III trials are actual clinical trials having control groups.

Phase 1 Trial: These usually constitute the first step towards clinical experimentation and research into new or improved drugs, etc. Animal experiments are also part of Phase 1 trial.

Advantages: Cheap and less time consuming

Purposes: Study of:

- The adverse effect of drugs
- Benefits of the drug
- Absorption, excretion, metabolism of drugs.

Phase 2 Trials (Quasi-experimental design): These generally constitute the second step during drug research. They may use a quasi-experimental study design that may or may not have a control group. They are more expensive than Phase 1 trials but are still less time consuming and yield better results.

Limitations: Cannot control for observer/assessors bias and bias due to sampling variation.

Purpose: To study:

- Benefits of drugs
- True effect of drugs.

Phase 3 Trials (True experimental design): These are also referred to as Randomized Controlled Trials (RCT).

- There is a clear control group similar to the experimental group
- The terms of follow-up and all other conditions are kept similar for the two groups
- Blinding, preferably double-blinding, is observed to minimize bias
- The subjects are randomly allocated to the treatment or the control group as per predetermined randomisation procedure.

Example: A new analgesic "A" is to be tried for post-operative pain. Its efficacy is to be compared with a standard analgesic "B" already in use. It has been decided to try both of them in patients who have undergone a particular type of surgery with similar results:

- Patients are randomly assigned to two groups;
- Either analgesic A or B is given to subjects in a particular group, the drug being contained in similar color coded packs;
- Two groups are followed postoperatively for 3 to 4 days to look at the pain scores;
- After the results have been compiled, the code is broken to form comparative groups.
- The results are then compared to look at the true difference between the two groups receiving analgesic A or B.

TYPES OF EXPERIMENTAL STUDIES

These may be as follows:

- Preventive or prophylactic trials
- Therapeutic or clinical trials
- Community (field) trials.

Preventive or Prophylactic Trials

Here intervention takes place before the disease has occurred, e.g. study of vaccines or risk factors (stress, smokers, etc). Example: vaccinating one group against hepatitis B and leaving the other unvaccinated to study the efficacy of Hepatitis B vaccine. The most famous and one of the earliest vaccine trials was the one carried out by Louis Pasteur to a nine-year-old boy Joseph Meister on July 6th 1885.

Therapeutic or Clinical Trials

A clinical trial is an experiment with patients as subjects. Hence, the unit of study is a patient. The goal is to evaluate one or more new treatments for a disease or condition. The major ethical dilemma in such a trial is to decide about using placebo, which is a preparation containing no medicine or no medicine related to the complaint and administered to cause the patient to believe he/she is receiving treatment. It may sometimes be difficult to decide while planning a drug trial as to whether the control group should be given placebo or the standard medicine against which the drug in question is to be tested.¹¹

Example

- Treatment of carcinoma breast comparing surgery, radiology and drug treatment.
- Studying a new drug for hypertension management and giving the drug to one group and placebo to another group.

Types of Therapeutic or Clinical Trials

Randomized Control Studies

These are comparative studies with an intervention group and control group. Subjects are assigned to intervention or control group as per proper predetermined procedure of randomization. Randomization is a process by which all subjects are equally likely to be assigned to either group.

Advantages

- Strong ability to prove causation
- Minimize or remove the potential bias in the allocation of subjects to intervention group or to the control group
- Randomization tends to produce comparable groups
- Randomization would guarantee the validity of statistical tests of significance.

Disadvantages: Ethical concerns like, depriving a subject from receiving a new therapy or intervention, which is believed to be beneficial regardless of validity of the evidence for that claim, i.e. randomized control trial deprives about one-half the subjects from receiving the new and presumed better intervention.

Nonrandomized Concurrent Control Studies

Here the subjects are assigned to either the intervention or the control group without randomization.

Advantages: Relatively easy to conduct by selecting the group of people to receive the intervention and selecting the control group by means of matching key characteristics.

Disadvantages: Intervention groups and control groups are not strictly comparable because of selection bias. This is a serious drawback and hence all efforts should be made to have random allocation system.

Historical Control Studies

Here a group of subjects on a new therapy or intervention is compared with a previous group of subject on standard or control therapy. In other words, a new intervention is used in a series of subjects and results are compared to the outcome in a previous series of comparable subjects. Such studies are, by their very nature, nonrandomized. The argument for using a historical control design is that all new subjects can receive the new intervention where it is felt that no subjects should be deprived of the possibility of receiving a new therapy or intervention.

Advantages

- Subjects may be more willing to participate in a study if they can be assured of receiving a particular therapy or intervention
- Less time consuming because all new subjects will be on new intervention and compared to a historical group
- Relatively cost-effective.

Disadvantages

- Potential for bias
- Results may be misleading because of:
 - Different structure and characteristics of the two groups
 - Shift in diagnostic techniques and criteria for the disease under study can cause major changes in the recorded frequency of the disease, thereby questioning the validity of the study
- Data for control group may not be accurate and complete.

Crossover Design

Here each subject participates in the study twice, once as a member of the intervention group and once as a member of the control group. It allows each subject to serve as his/her own control. In other words, each subject will receive, at different times, both treatments A or B. The order in which A or B are given to each subject is randomized.

Advantages: It allows assessment of whether a subject does better on A or B. Since each subject is used twice, once on A and once on B, the possibility of individual differences between subjects affecting the comparison of two groups are minimized. In other words, variability is reduced because the measured effect of the intervention is the difference in the individual subject's response to intervention and control. This reduction in variability means that the sample size needed is smaller.

Disadvantages: Effects of intervention during the first period may be carried over into second period. Hence, this design should be used only when there is ample evidence that the therapy has no carry-over effects.

Withdrawal Studies

Such study design is used when subjects on a particular treatment for chronic diseases are taken off therapy or have the dosage reduced. The objective is to assess response to discontinuation or reduction of the drug or its dose. The study is conducted using necessary randomization as safeguard against bias.

Advantages: This design may be validly used to assess the efficacy of an intervention that has never conclusively been shown to be beneficial.

Disadvantages

- The study sample is a highly selected one. Only those subjects are likely to have been on a drug for several years who, in the opinion of the physician, are benefiting from the intervention. Any one who has major adverse effects from drug would have been taken off and not been eligible for the withdrawal studies.
- Subjects and disease status may change over time so the results may be misleading.

Factorial Design

Here the attempt is to evaluate two interventions compared to the control in a single experiment. This design, with appropriate sample size, can be very informative when there is little chance of interaction.

Factorial Design

	Intervention A	Control
Intervention B	a	b
Control	c	d

$a = A + B$
 $b = B + \text{Control}$
 $c = A + \text{Control}$
 $d = \text{Control} + \text{Control}$

Advantages

- With little increase in sample size two experiments can be conducted in one go
- Used for determining the interaction of two drugs.

Disadvantages

- There may be interaction between two groups, meaning thereby that the effect of intervention A may differ depending upon the presence or absence of interaction B, or vice versa. It is more likely to occur when the two drugs are expected to have related mechanism of action.

Group Allocation Design

Here a group of individuals, clinic(s) or community is randomized to a particular intervention or control. Such design is ideal when there is difficulty in approaching the individuals about the idea of randomization. Giving all subjects a specific intervention may be quite acceptable. In this design the basic sampling units are groups, not individual subjects.

Studies of Equivalency

In some instances, an effective intervention has already been established and is considered the standard. New interventions under consideration may be less expensive, have fewer side effects, or have less impact on an individual's general quality of life, and thus may be preferred. Studies of this type are called studies of equivalency or trials with positive controls. The objective is to test whether a new intervention is as good as an established one. The control or standard treatment must have been shown to be effective, that is, truly better from placebo or no therapy. It cannot be statistically shown that two therapies are identical, as an infinite sample size would be required. Hence, if intervention falls sufficiently close to the standard, as defined by reasonable boundaries, the two are claimed to be the same. The investigator must specify what he/she means by equivalence. It means specifying some value "d", such that two interventions with difference less than "d" might be considered equally effective or equivalent. Specification of "d" may be difficult but, without it, no study can be designed.

COMMUNITY (FIELD) TRIALS

They involve intervention on a community-wide basis. Here, the unit of study is a community. These are trials which are conducted on communities instead of individuals. Appropriate randomization should be used as far as possible, though this may sometimes be difficult due to practical considerations. They require greater number of subjects than clinical trials and, hence, are more expensive.

Examples

- Fluoridation trials for prevention of tooth decay.
- Deworming trials for ascariasis.^{12,13}

SUMMARY OF THE METHODOLOGY OF INTERVENTION TRIALS

- Formulation of hypothesis.
- Decide the methodology for studying the affect of the independent variable on the dependent variable.
- Develop strategies for measuring the outcome and controlling the independent variable.

- Decide on allocation of subjects to exposed versus nonexposed groups using carefully selected randomization technique.
- Take informed consent of the study population.
- Follow the study population forwards in time.
- Collect and analyze the data.
- Conclude by accepting or rejecting the original hypothesis/assumption.

BLINDING IN EXPERIMENTAL TRIALS

One of the main concerns in an experimental study is bias. It can occur at various stages of the trial, from the initial design through data analysis and interpretation. The general solution to the problem of bias is to keep the subject and investigator blinded to the identity of the assigned intervention.¹⁴

Un-blinded Clinical Trials (Open Trial)

Here the identity of the intervention to which a subject is exposed or assigned is known both to the subject and the investigator.

Advantages

- Simpler to execute than other studies
- Investigators are likely to be more comfortable making decisions if they know its identity.

Disadvantages

- Has more potential for biases
- The preconceived notions about the benefit of a treatment in the minds of the investigator as well as the subject may lead to biased reporting on the part of the subject; and also biased observation and recording on the part of the investigator

The disadvantages mentioned above far outweigh the advantages, which are based more on convenience. It is always better to avoid bias and to have some degree of blinding as appropriate.

Single blinding: The subject does not know about the nature of intervention as to whether he is getting the drug or the placebo, but this is known to the investigator. Hence, the potential for observer bias certainly exists.

Double blinding: It is a superior form of blinding and probably the best protection against observer bias. In this method neither the subject nor the investigator knows who is getting what. Such a procedure is not always feasible as the drug being tested may produce side effects that are not mimicked by the placebo. The physician may need information about the patient's assignments to closely monitor his clinical status. The last one can be overcome by a third physician who is not evaluating the results. The reasoning for such masking is that the experimental and control groups should be followed with equal intensity for evaluation of the outcome.

Triple blinding: In this type the subject, investigator and also the data analyst are unaware of the assignment. Once the study is completed and the results are analyzed the code is broken. Such a study guards against assignments of equivocal cases or interpretation of outcomes. Such a study is generally not feasible and is not very popular.

	Patient	Observer	Researcher
Unblind	–	–	–
Single blind	+	–	–
Double blind	+	+	–
Triple blind	+	+	+

Some considerations while designing experimental studies

- *Ethics*—informed consent, confidentiality and respect for human rights
- *Cost*—man, money, material, time, etc.
- *Feasibility*—practicability, resources, severity of the problem.

Bias in Epidemiological Study

During the collection and interpretation of information there may be some effect, which may leads to an incorrect estimation of the association between exposure and risk of disease.

DEFINITION

Any systematic error in an epidemiological study that results in an incorrect estimation of the association between exposure and risk of disease.

TYPE

Two broad categories.

Selection Bias

Error that arises during the processes of selection of study subjects. A bias sample is not a representative of the parent population. If a different criterion is used in selection of cases and controls bias may be introduced in a retrospective study where both the exposure and disease has already occurred. There is little chance of this type of bias in prospective study as exposure as ascertained beforehand. Selection bias once occurred may not be rectifiable so this should be taken care of during study design.

Observation or Information Bias (Called Non Sampling Bias)

Any systemic error that arises during the measurement of information on exposure and outcome. This include shortcoming in collection, recording coding, analysis, etc.

If the sample is not representative of the target population bias may arise. Types of observational biases:

Recall bias: Different individual may remember and report past experience differently thus giving different degree of completeness or accuracy, as result comparability may not be ensured. This type of bias particularly seen with retrospective study. Recall bias can be either over estimate or under estimate the association between an exposure and the disease depending upon the respondent's recall ability.

Interviewer's bias: This may arise due to difference in soliciting, recording or interpreting information from study subjects. Previous knowledge about an exposure and outcome of a disease may affect the recording of information in a biased manner. Blinding technique can minimize this type of bias.

Bias due to loss of subjects to follow-up: When the subjects lost due to follow-up differ from sample remaining in studying respect of exposure and outcome, any association observed may be biased. To reduce this bias, some measure should be incorporated in the planning stage of study design so that additional source of information may be utilized if required, e.g. vital record, telephone call to dropouts, written communication, etc.

Bias due to miss classification: When information or observations in respect of exposure or outcome (e.g. disease status) are erroneously classified, this may be a potential source of bias. This type of bias commonly found with retrospective studies as the study often obtain exposure information from records taken many years before the initiation of study. Self-reported exposures have more chance of misclassification.

Hospital base statistics related bias: Hospital base statistics cannot be regarded as the representative of all the cases of that disease. Differential response or refusal rate or dropout rate between the cases and controls may lead to bias in the study. Berksonian's bias arises due to difference in admission rate in a hospital for the people with different diseases (case and controls). If we compute the fatality rate of any disease from hospital statistics without considering the milder cases being treated at home, it may introduce bias as only seriously ill patient may be admitted in hospital.

CONTROL OF BIAS

- *By careful study designing:* Some type of bias can be minimize or control by selecting a suitable study design and appropriate analysis.
- Ensuring comparability between study and comparison group.
- *Choice of study population:* Choice depends on research question and type of study. Selection of hospitalized control in a case control study will

increase the comparability by improving willingness to participate, similar environmental influence, decrease the possibility of nonresponse rate. To prevent the loss due to follow-up, a well-defined population in respect of occupation, residence or some other characteristics (alumni, association, etc.) should be chosen.

- *Methods of data collection:* There are different means of data collection which may affect the validity of result. *Development of specific instrument* to obtain information (questionnaire, checklist, examination protocol, etc.), rigorous *standardize training of observers* and *use of clearly written protocol* will help to reduce bias in the study. Highly objective close-ended questions are preferable in this regard. Methods and source of data collection should be same for study and control group. Inter-observers variation can be minimize by deploying *trained observers* and taking *average of several observations*.
- *Blinding:* Observers bias can be reduced by blinding during administration of data collection instrument, abstracting record, interview or examination of subjects. Blinding can be incorporated in respect of subjects/or investigators/or analyst depending on the type of study.

CLINICAL TRIAL

Clinical trial is an organized research, conducted on human beings to investigate the safety and efficacy of a drug. Clinical trial must conform to the moral and scientific principles that justify medical research and should be based on laboratory and animal experiments or other scientifically established facts.¹⁵

NEW DRUG DEVELOPMENT PROCESS

Drug discovery requires two basic steps, i.e. research and development.

Research: This phase consists of three sequential activities comprising of target selection, drug selection and product development. The first phase, target selection, involves choosing a disease to treat and then developing a model for that disease. The second phase, drug selection, is a process that involves finding a drug or group of drugs that work within that model system. Typically the screening process involves hundreds of compounds that are tested against the target. When the compounds with the desired activity are discovered, the most promising among them are optimized to produce one or two final compounds that may eventually become drugs. The entire process from target selection to product development usually takes at least 3 years, and can involve hundreds of researchers and millions of dollars.

Development: Then comes the drug development process, which consists of preclinical and clinical development (clinical trial).

PRECLINICAL DEVELOPMENT

Preclinical tests are performed in the laboratory, using a wide array of chemical and biochemical assays, cell-culture models and animal models of human disease. This preclinical testing develops pharmacological profile of the drug, determines acute toxicity of the drug in at least two species of animals and conducts short-term toxicity studies. The ultimate aim of preclinical testing is to assess safety and biological activity in animals. This phase takes about approximately 4 years. After completing preclinical testing, an Investigational New Drug application is filed to begin to test the drug in human. If regulatory body does not disapprove it within 30 days, then this application becomes effective, and at this stage clinical trial can be initiated.

Clinical trials on patients in different countries are approved and monitored by different regulatory agencies, which, in India, is monitored by Drug Controller of India (DCGI) under Central Drug Standard Control Organization (CDSCO). The total duration of these trials may stretch to approximately 8-9 years. Clinical research is done in four phases (I, II, III and IV), each designed to address different issues. The knowledge gained from one phase is utilized in the subsequent phases.

Phase I trial (Human Pharmacology): The main objective of this phase is to establish initial safety, maximum tolerance and pharmacokinetics of the drug in humans. This phase is usually carried on 20-80 healthy human volunteers or certain types of patients. The time period being approximately 3-6 months. This phase is also known as 'First in Man'. In case the drug to be investigated has a known potential adverse effect, the study is carried on upon subjects only for whom the drug is targeted, e.g. anticancer drugs are never tested in healthy volunteers, rather it is investigated on cancer patients. Only about 70% of experimental drugs pass phase I trial.

Phase II trial (Therapeutic Exploratory Trials): On completion of the Phase I trial, the Phase II trial is initiated to evaluate the safety and efficacy of the drug. This phase is conducted on patients either in an open, non-blind or as placebo control, blinded trials. Here 100-300 patients are enrolled to determine the dose and adverse reactions of the drugs. This phase may last from 6 months to two years. This phase is further divided into two subtypes—Phase IIa and IIb.

Phase IIa: Pilot clinical trials to evaluate safety in selected patient population (dose response, type of patient, etc.)

Phase IIb: Controlled clinical trials to evaluate safety as well as efficacy for determining a dose range to be studied in phase III.

Only about 35% of experimental drugs pass phase II trial.

Phase III trial (Therapeutic Confirmatory Trials):

This phase involve several hundred to several thousand patients and may last for 1-5 years conducted in multicentric manner. Drugs safety and effectiveness are being studied in different patient subgroups like children, elderly and patients having hepatorenal impairment. Once this phase III trial has been completed successfully, the drug company is in a position to apply to the regulatory authorities for marketing approval. This phase again is of two subtypes—IIIa and IIIb.

Phase IIIa: Conducted after the drug's efficacy is demonstrated but before the regulatory submission of New Drug Application (e.g. studies in children, patient with renal dysfunction, etc.)

Phase IIIb: Conducted after regulatory submission but prior to the drug's approval or launch (e.g. to supplement or complement earlier trials).

Only about 25% of experimental drugs pass through phase III trial.

Phase IV trial (Postmarketing Studies/Trials): Post-marketing trials are studies (other than routine surveillance) performed after drug approval and related to the approved indications. After the prior demonstration of the drug's safety, efficacy and dose definition in the previous trials, this phase is concerned with the application of the drug in general population. Drug may be withdrawn from the market if some notorious side effects are noticed in phase IV trial, just what happened in Thalidomide tragedy in 1962.¹⁶

New Drug Development is a very long journey, as it takes 12 years and ~ 800 million US \$ to bring one new drug to market. To start with 5,000-10,000 compounds are initially screened in preclinical development, subsequently 250 enter in preclinical testing and 5 enter in clinical testing, ultimately 1 compound is approved by the Food and Drug Administration of USA (FDA).

Schedule Y: Requirements and guidelines for permission to import and or manufacture of new drugs for sale or to undertake clinical trials are mentioned in the schedule. Application for permission to import or manufacture new drugs for sale or to undertake clinical trials are made in Form 44 with data of chemical, pharmaceutical information, animal pharmacology data (that includes specific pharmacological actions, general pharmacological actions and pharmacokinetic data), animal toxicology data, human clinical pharmacology data, regulatory status of the drugs in other countries, complete testing protocols and indication of drugs, purpose of examination and application for import of small quantities of drugs.

REGULATORY FRAMEWORK

Before a clinical trial is initiated it is imperative to follow international ethical and scientific quality standard for

designing, conducting, recording and reporting of clinical trials that involve participation of human subjects. Compliance with this standard provides assurance that the rights, safety and well being of trial subjects are protected, consistent with the principles laid down by Declaration of Helsinki and the data are credible.^{17,18}

In India, the regulatory framework is governed by these following guidelines:

- International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human use—Good Clinical Practice: Consolidated guideline (ICH-GCP, 1997).¹⁹
- Local Regulatory Requirements (DCGI).
- Indian Council of Medical Research (ICMR code, 2000).²⁰
- Local Ethics Review Boards (ERBs).

GOOD CLINICAL PRACTICE

Good Clinical Practice (GCP) is an international ethical and scientific quality standard for designing, conducting, recording and reporting trials that involve the participation of human subjects. Compliance with this standard provides public assurance that the rights, safety and well-being of trial subjects are protected, consistent with the principles that have their origin in the declaration of Helsinki and the clinical trial data are credible.

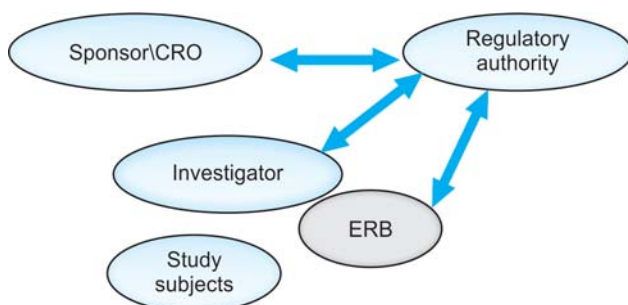
Before a trial is initiated, foreseeable risks and inconveniences should be weighed against the anticipated benefit for the individual trial subject and society. A trial should be initiated and continued only if the anticipated benefits justify the risks.

RATIONALE OF GOOD CLINICAL PRACTICE

- Legal requirement for conduction of the trial.
- Protects the rights, integrity and confidentiality of research subjects.
- Provides assurance that the data and results are credible and accurate.
- Global acceptance of the data.

Ethics Review Board

It is an independent body constituting of medical or scientific professionals and nonmedical or nonscientific



members, whose responsibility is to ensure the protection of rights, safety and well being of human subjects involved in a trial. No clinical trial is initiated at any investigator site without obtaining a written permission by the review board. This board reviews protocol of the proposed study, informed consent document and its translation in vernacular language, all clinical and non-clinical data of the investigational product, grants, study advertisement, investigator's qualification and trial permission by DCGI/FDA. The Ethics Review Board comply with GCP and other applicable regulatory requirements.

CLINICAL TRIAL STAKEHOLDERS

There are three pillars in conducting clinical trial, i.e. Sponsor/CRO, Investigator and Regulators.

CONDUCTION OF CLINICAL TRIALS

Different Pharmaceutical Companies, Biotechnology Companies, Contract Research Organizations (CRO), Research/Academic Institutions and Cooperative Groups can conduct clinical trial.

ETHICS IN CLINICAL TRIALS

India is today poised as one of the favorable destination for conducting global clinical trials due to the availability of large patient populations, skilled manpower, cost effectiveness, favorable economic environment, etc.

The Declaration of Helsinki (*DoH*) is the World Medical Association's (WMA) best-known policy statement. The first version was adopted in 1964 and has been amended six times since, most recently at the General Assembly in October 2008. Its purpose was to provide guidance to physicians engaged in clinical research and its main focus was the responsibilities of researchers for the protection of research subjects.^{17,18}

The Clinical Trials Registry encourages the registration of all clinical trials conducted in India before the enrolment of the first participant. The registry is meant to bring transparency to clinical trials conducted in India. Thus, a concerted effort on the part of the global public health community was made to push clinical trials related issues to the fore in the wake of several high-profile cases in which pharmaceutical companies were shown to be withholding information from regulators. The World Health Organization (WHO) has played a catalytic role in pushing this process forward. Though the launch of the Clinical Trials Registry marks a new chapter in the clinical trial registration process in India, there are daunting challenges ahead. Since its launch in 2007, 64 clinical trials have been registered, but there is still no legal obligation to register. Steps are being taken to encourage voluntary registration, including the Clinical Trials Registry workshops to which people likely

to be conduct WHO clinical trials—medical colleges, research institutions, state drug controllers, and nongovernmental organizations—are invited, but for some countries like ours, such steps are inadequate.¹⁵

Fewer than 40 Ethics Committees in India are properly constituted and functioning, which means that the safety of the subjects of clinical trials is on the back burner, and that it is also worrying that there is no legal requirement for investigators or members of the Ethics Committees to declare a conflict of interest. Thus it is one of the serious problem given the increasing number of hospitals now owned by drug companies.¹⁵

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The word 'environment' is derived from an French word 'environ' meaning 'encircle'. Earth's environment is a rich heritage handed over to us by previous generations.

Environment may be classified as physical, biological and social for the purpose of studying its role in health and disease. In this chapter, a few general comments about human health and physical environment will be made before describing the role of air in health.

Cleanliness or sanitation of physical environment such as air, water, food and dwelling place is essential for healthy living. According to WHO, *environmental sanitation* means "The control of all those factors in man's environment which exercise or may exercise a deleterious effect on his physical development, health and survival".

It is due to the sanitation measures that there has been spectacular reduction in water and food borne diseases in USA and other Western countries. Control and eradication of malaria, filaria, yellow fever and other vector borne diseases is also attributed to the same. It has made a substantial contribution to positive health and longevity of life. In developing countries like India, where environment is still not clean, water, food and vector borne diseases such as cholera, typhoid, food poisoning and malaria are responsible for significant morbidity and mortality.

The important components of the physical environment are:

- Air
- Water
- Soil and housing
- Place of work, such as office and factor (occupational health)
- Wastes such as refuse and human excreta
- Food.

These components should be in such a state that they are favorable for the host (man) and unfavorable for the survival and growth of agents (microbes). These will be described in the present and the next five chapters. The role of food as part of man's environment will be discussed in the chapter on "Food and Nutrition".

It has been known for long that physical factors influence human body in several ways, though the concerned mechanisms are not clear. Some of the effects listed 25 years ago are as follow:¹

- 81 percent fatal and 75 percent nonfatal car accidents in Ontario between June and Sept. 1968, occurred when barometric pressure was falling.

- There is direct relation between sunshine and conception. An eight-year survey in Sussex showed that conception occurred mostly, during May to August, when sunshine is more. Regardless of season, conceptions throughout the year occurred more on those days when there were more sunshine hours.
- An analyses of 2000 murders in Florida between 1956 and 1970 showed high peaks in homicide rates coinciding with phases of full and new moon.
- A survey of 10,000 women with regular menstrual cycles in Germany revealed that an unduly high proportion of cycles commenced at the time of full or new moon.

Air

Air forms the most immediate environment of man with which he is in constant contact throughout his life. The importance of clean air for man's health is thus self-evident. Even from a symbolic point of view, it is well to keep in mind that while a man consumes 1.2 kg of solid food and drinks 1.8 kg of liquids, he breathes as much as 14 kg of air per day.^{1a}

The air atmosphere with which man comes into contact is of two types:

1. External atmosphere, i.e. air space outside the room.
2. Internal atmosphere, i.e. air space inside the room of a building.

They are certain agents in the atmosphere to which man is constantly exposed. These agents affect his physical well-being and may cause discomfort, injury or disease. They may be divided into physical, chemical and biological agents, as follows:

PHYSICAL AGENTS

- Temperature
- Humidity
- Wind velocity
- Pressure of atmospheric air.

CHEMICAL AGENTS

Dust, soot, smoke, other organic and inorganic particles emanating from houses, factories and vehicles, etc.

BIOLOGICAL AGENTS

Bacteria and viruses, etc.

Factors Affecting Atmospheric Environment

METEOROLOGICAL VARIABLES

- Degree of sunshine
- Atmospheric pressure
- Humidity
- Rainfall
- Velocity and direction of wind
- Air temperature.

The sum of these variables over a period of months or years is referred to as the climate of a place (weather, on the other hand, denotes these conditions at a particular moment or time). Good climate and pleasant weather are soothing and health promoting.

GEOGRAPHICAL CONDITIONS

- Distance from the equator
- Distance from the sea and height above sea level
- Nature of soil (rocky, sandy, loamy or clayey) and
- Terrain (plain or hilly).

The above factors modify the climate by bringing about changes in temperature, rainfall, humidity, direction and velocity of winds and atmospheric pressure.

HUMAN ACTIVITIES AND INDUSTRIES

Man adds heat, humidity, microorganisms and odors to the air around him through various physiological functions of the body. Household activities and industries add noise, radiation, smoke, soot and various types of dusts to the atmosphere which may become detrimental to healthy living.

Physical Agents in Atmosphere

i. Temperature

ii. **Sunshine:** This can be measured with the help of Campbell-Stoke sunshine recorder.

iii. **Humidity:** Absolute humidity is the actual weight of moisture or water vapor in a unit volume of air at a particular temperature and is expressed as gram per cubic meter of air. Relative humidity (RH) is the ratio of absolute humidity at a particular temperature to the weight of water vapor, when the air is fully saturated at the same temperature. It is calculated as a percentage. It tells how much more moisture can be taken by the air at a particular temperature and thus indicates comparative dryness or wetness of the air.

$$RH = \frac{\text{Weight of water vapor in one cubic metre of air say at } 30^{\circ}\text{C}}{\text{Weight of water vapor in one cubic meter}} \times 100$$

fully saturated air at same temperature

Humidity is commonly measured by using dry and wet bulb hygrometers. Relative humidity can be found from specially constructed psychrometric charts. RH below 30 percent indicates that the air is too dry causing drying of nasal mucosa. RH above 65 percent indicates excessive humidity, causing the room air to feel uncomfortable and sticky. However, excess humidity is not known to cause any ill effects on physical health.

Rain: Rainfall is measured with the help of rain gauge. Symon's rain gauge has a funnel of 5 inches diameter for receiving the rainfall.

Air motion: Direction of the prevailing wind is indicated by wind vane. The velocity is measured by an anemometer. Wind up to 0.5 meter per second (m/s) is calm air when smoke can be seen rising vertically. Wind at 0.5 to 1.5 m/s is called light air. Light breeze, breeze and strong breeze have velocities of 1.75 to 3, 3 to 9 and 9 to 14 m/s respectively. Gale and storm have velocities of 14 to 28 and 28 to 32 m/s respectively. Beyond that it is a hurricane. Wind direction and velocity modify the air temperature, which in turn affects the power of body to gain or lose heat.

Atmospheric pressure: It is measured by Fortin's mercury barometer or aneroid barometer. The latter is convenient, though less sensitive.

Acclimatization to Physical Agents in the Air

HIGH TEMPERATURE

Heat loss from the body occurs mainly through the skin by convection, radiation and evaporation. Hot, humid and stagnant air takes less heat from the skin than cool, dry and moving air.

Exposure to sudden and prolonged heat without prior acclimatization leads to ill-effects which may be local or general. These ill-effects are accentuated in the presence of high humidity and lack of air movement.

Local Effects

These include darkening of skin, prickly heat, sunburn, dermatitis.

General Effects

Heatstroke: It is characterized by hyperpyrexia (108°–112°F) along with giddiness, anorexia and frequency of micturition followed by unconsciousness. There is sudden cessation of sweating, the cause of which is not known. This leads to failure of heat regulating mechanism. Mortality is more in young children and old people, especially if they are ill-nourished.

Heatexhaustion: It is due to profuse sweating chloride (between 0.2 and 0.5 percent) with specific gravity

1.002 to 1.003 and pH 4.2 to 7.5. The fluid loss may be as high as 1 liter per hour, especially if there is muscular exercise. Body temperature, instead of being high, may be subnormal. Blood pressure is low and pulse is fast. The patient feels faint, weak and, at times, dizzy and lethargic.

Heatcramps: Due to excessive loss of salts in the sweat, there is increased muscular irritability. Painful spasms of skeletal and abdominal muscles may develop.

LOW TEMPERATURE OR COLD CLIMATE

Physiological adjustment takes place to conserve body heat. There is peripheral vasoconstriction, shallow respiration and rapid pulse. Urine becomes acidic and dilute and is passed more often. Extra heat is produced by shivering.

Failure of adjustment to low temperature leads to illeffects that may be local or general.

Local Effects

Frostbite occurs when the tissues are actually frozen on exposure to temperature below 0°C. Immersion foot or trench foot occurs when feet are immersed in cold water or snow. High humidity and wind velocity, fatigue and anoxia at high altitude worsen the situation.

General Effects

These include pains and aches in joints and muscles, digestive disturbances, respiratory disturbances such as cold, bronchitis, pneumonia and, in serious cases, peripheral vasoconstriction, anoxia and death.

HUMIDITY

It makes the warm climate warmer and cold climate colder. In warm climate, heat loss from the skin is prevented because humid air cannot dry off much sweat or moisture from the skin. In cold climate the moist air, being a better conductor than dry air (water is 23 times better conductor of heat than air), causes more heat loss from the body.

MOVEMENT OF AIR

Wind velocity makes the hot climate cooler but cold climate colder. Hot air near the skin is replaced by dry and cool air from the atmosphere thus facilitating heat loss from skin. In cold climate wind movement increases heat loss from the body by causing replacement of warm air near the skin by cold atmospheric air.

LOW ATMOSPHERIC PRESSURE

It is experienced at high altitudes. Because of the low pressure of oxygen at high altitude, the amount of

oxygen taken by RBCs is decreased, to compensate for which the body manufactures more RBCs. Respiration and pulse rate are increased. The critical height up to which body can acclimatise without much symptoms is 4300 to 5500 meters (14000 to 18000 ft). The height of 7000 to 7600 meters (23000 to 25000 ft) is critical for survival. Air pressure at 35,000 ft (10688 m) above the earth is 3.46 lbs, per sq inch, i.e. one-fourth of that at sea level. Jets fly at 31,000 to 32,000 ft and their cabins are pressurised. Mountaineers carry oxygen with them and have to use it above 25,000 ft. Persons having anemia and cardiac or pulmonary disease, particularly asthma, should avoid exposure to high altitude.

HIGH ATMOSPHERIC PRESSURE

This is experienced by divers going deep down in the sea in diving bells or caissons. Due to increased pressure, more oxygen and even nitrogen get dissolved in the blood. If decompression is not slow, emboli of nitrogen are formed leading to air embolism and death. Precautions taken for acclimatization are gradual compression and decompression by passing the workers through air-locks. Helium is used instead of a nitrogen as it is less soluble in blood.

Chemical Agents in Atmosphere

Air is said to be polluted when physical, chemical and biological agents are present in it to such an extent that they become harmful to man.² Pollution of external atmosphere by chemical agents and smoke is a growing menace in large industrial towns. More than 100 pollutants arising from different sources are added into the air everyday. Various types of pollutants are listed in **Table 5.1**.

Sources of Pollution

Common sources of chemical pollutants in large cities are:

TABLE 5.1: Various types of pollutants

- Gases and vapors such as carbon monoxide, sulfur dioxide, ammonia, organic sulphides, aldehydes, acetones and aromatic hydrocarbons
- Fumes of lead and other chemicals with particles of size 1 micron or above
- Dusts suspended in the air such as grit, soot, earth, sand, Pb, Mn, Fe, Zn, pollens, fibers, etc.
- Radioactive dusts and isotopes
- Smoke, which is an aerosol with particle size below 0.5 micron. It consists of:
 - Unburnt carbon, CO, CO₂, NO₂, NH₃, HNO₃, SO₂, H₂SO₄ and mercaptan
 - Pyroigneous acid and acetic acid in wood smoke
 - Hydrocarbons, naphthalene, paraffin, phenanthrene, benzpyrene, chrysene (last 5 are well known carcinogens).

INDUSTRIAL PROCESSES IN DIFFERENT INDUSTRIES

Various chemicals are emitted into air as in fertilizer, paper, cement, steel and insecticide factories and oil refineries.

COMBUSTION

Burning of coal, oil and other fuels in houses and in factories adds smoke, dust and sulfur dioxide to air.

MOTOR VEHICLES

Through their exhausts, they add to air carbon monoxide, hydrocarbons, formaldehyde, nitrogen oxides, lead, etc.

MISCELLANEOUS

Plants, yeast, molds and animals emit various allergenic materials. Insecticide sprays in agriculture also add to air pollution.

Three major sources of air pollution in a city are industrial, domestic and vehicular. The relative contribution of these sources in the metropolitan cities of India is shown in **Table 5.2**.

REDUCTION VEHICULAR POLLUTION

The existing vehicular standards in India as per the Motor Vehicles Act in terms of carbon monoxide emitted during free acceleration are as follows:^{3a}

Petrol vehicles (in terms of % volume)

2 and 3 wheelers	4.5%
4 wheelers	3%

Diesel vehicles (in terms of hartridge units) 65 units

In comparison, the standards prevalent in USA and Japan are more stringent and given in **Table 5.3**. A decision has been taken to gradually bring the Indian stan-

TABLE 5.2: Sources of air pollution in Indian cities (1990-91). Figures in parentheses indicate the expected figure in year 2000-2001³

Source	Kolkata	Mumbai	Delhi
Industrial	72% (74%)	54% (48%)	29% (20%)
Transportation	20% (22%)	42% (48%)	63% (72%)
Domestic	8% (4%)	4% (4%)	8% (8%)

TABLE 5.3: Vehicle pollution safety standards (Emission per unit distance)

Pollutant	Japan	USA	
	g/km	g/mile	g/km
Nitrous oxides	0.48	1.00	0.63
Carbon monoxide	2.70	3.40	2.13
Carbohydrates	0.39	0.41	0.26

dards in line with the international ones in a phased manner, as suggested by Central Pollution Control Board.⁴

Major pollutants emitted by different types of vehicles are as follows:^{3a}

Two stroke engines : Lead compounds, carbon monoxide

Four stroke engines : Hydrocarbons, nitrogen oxide

Diesel engines : Smoke, odor, sulfur dioxide.

Measures to reduce vehicular pollution are listed below:

Use of 4 stroke engine: Four stroke engines used in four wheelers are more fuel efficient, releasing less unburnt or partially burnt fuel into atmosphere. They cause less pollution. Two-stroke engines are mainly used by two wheelers and three wheelers. Some newer brands of motor cycles in India are already using a four-stroke engine. There is a proposal to discourage or ban the use of two stroke engine in vehicles in future. It may be mentioned that comparing a car with a two wheeler having two stroke engine, the amount of emission per passenger is higher in case of the latter (2 times for carbon monoxide and 8 times for hydrocarbons).

Use of lead free petrol: Tetraethyl lead is added to petrol in the oil refineries so as to increase the octane properly of fuel. High octane level in fuel prevents engine damage due to knocking and increases engine efficiency. However, at the same time, addition of lead to petrol means emission of lead compounds in the vehicle exhaust causing lead pollution. The quantity of lead added to petrol is 0.56 g/l as per specifications of the Bureau of Indian Standards. A decision has been taken to ultimately stop adding lead to petrol in India. The first step was taken in June 1994 when the level of lead in petrol in the metropolitan cities of Delhi, Mumbai, Kolkata, and Chennai was brought down from 0.56 g/l to 0.15 g/l. With effect from 1.4.95, lead free petrol (containing not more than 0.023 g/l) is being supplied in the four metros. This has become necessary in view of the use of catalytic converters, which are inactivated by lead.⁵

Use of catalytic converters: A catalytic converter is a device fitted near the tail-pipe of the vehicle to change the noxious emissions released from the combustion system to harmless by-products. A typical catalytic converter has coatings of noble metals such as platinum, rhodium and palladium which oxidise the pollutants such as carbon monoxide and hydrocarbons to carbon dioxide and water vapor. In a three-way catalytic converter, oxides of nitrogen, which are also a major group of pollutants, are reduced to atmospheric nitrogen. Thus a catalytic converter can, within seconds, reduce highly polluting substances to harmless compounds reducing the pollution load from vehicles fitted with such converters.

A catalytic converter costs about Rs. 10,000/- and has to be changed every 100,000 km. Its use has been

made mandatory for all new cars sold with effect from 1.4.95 in the four metros. However, the use of lead free petrol is a must for a vehicle fitted with a catalytic converter so as to avoid damage to the latter. That is why lead free petrol has been made available in these four metros simultaneously.

Use of CNG: Compressed natural gas (CNG) is being used as a fuel in place of petrol or diesel in more than 5 lakh vehicles in the world.⁵ Maximum such vehicles are in Italy (2.5 lakh) followed by Argentina (1 lakh) and New Zealand (50,000). A beginning in this direction has been made in India also. The use of CNG is almost pollution free.

A major source of sulfur dioxide is burning of coal. Sulfur dioxide pollution is the principal cause of acid rain. It is because of this that USA passed the Clean Air Act, 1990, aimed at cutting down the annual sulphur dioxide production from 19,000 to 9000 tonnes by 2000 AD.

The quality of local air is influenced by the proximity of large scale utilities and industries, vehicle density, residential heating and open incineration, etc. Regular monitoring of air pollution trends in 10 cities since 1976 by the National Environmental Engineering Research Institute, Nagpur, has shown that Kolkata is the most polluted city in terms of suspended particulate matter (527 mg per cubic meter) and sulfur dioxide pollution (0.021-0.058 ppm). Kochi was found to be least polluted.⁶

Assessment of Air Pollution⁷

Common indices in use are:

DUSTFALL

Heavy particles in air settle down as dust. The amount collected per month is measured and calculated in tonnes per sq km.

SUSPENDED PARTICLES

Minute particles suspended as soot and fine dust are measured in terms of mg or micrograms of particulate matter per cubic metre of air.

SMOKE INDEX

Air is filtered through a paper disk and the discoloration produced by smoke is measured by a photoelectric meter. It is expressed as Coh units per thousand linear feet of air.

SULFUR DIOXIDE

It is produced by burning of fossil coal (in contrast to charcoal) and fuel oil. It is measured routinely in all pollution surveys. It is a very important indicator of pollution.

Besides the above, the air content of carbon monoxide, nitrogen dioxide, lead and various oxidants is also used as an index of air pollution.

Temperature Inversion

Wind movements play an important role in diluting the concentration of various pollutants in the air. These movements are horizontal as well as vertical. Vertical air movements occur because of the temperature difference in layers of air at different heights from the surface of the earth. Normally the air becomes colder as we go up with the result that polluted air moves up and gets dispersed to long distances. This is particularly made possible by the fact that horizontal wind velocity is much more at higher altitudes. Sometimes there may be inversion of temperature difference. In other words, temperature near the earth may be less than that in the air above. The result is that the usual vertical air movements do not take place and the polluted air near the ground does not rise up. Consequently the concentration of pollutants in air may reach dangerously high levels. Temperature inversion is particularly prone to occur in valleys and low lying places during the colder parts of the year and at night when solar heating of ground air is minimal.

Effects of Air Pollution on Health

- Sudden air pollution and smog (smoke and fog) are associated with immediate increase in general morbidity.
- Conjunctivitis, dermatitis, chronic bronchitis and lung cancer are due to irritants and carcinogens in smoke and other pollutants.
- Smoke cuts off ultraviolet light, thereby reducing the useful effects of sunshine (formation of vitamin D and sterilization of air by killing microorganisms).
- Dusts cause pneumoconiosis. These are described in detail in the chapter on "Occupational Health".
- Pollutants, particularly smoke, adversely affect plant and animal life and damage property. For example, the discoloration of Taj Mahal during last 10 years has been attributed to pollutants from the nearby Mathura refinery.

The problem of air pollution has reached a critical level in big cities in many countries. In India, air in Delhi and Mumbai is highly polluted. Even air pollution epidemics have occurred now and then. The London epidemic (1952) resulted in the death of 4000 persons within 12 hours. "Asthma epidemics" in New Orleans and Tokyo also occurred because of air pollution.⁸ Two other well-known air pollution epidemics in USA occurred in Los Angeles and Donora in 1948.

Prevention and Control of Pollution

GENERAL PRINCIPLES

The WHO⁹ has listed the following five general principles to control of pollution:

1. *Containment:* Preventing the pollutants from escaping into air from the source of production.

2. *Replacement*: Changing the existing techniques to those producing less amount of pollutants.
3. *Dilution*: Diluting the concentration of pollutants in the air to such a level that they can be removed by natural means, such as foliage.
4. *Legislation*: Enacting suitable laws aimed at prevention of pollution.
5. *International action*: The WHO has established two international pollution monitoring centers at Washington and London, three regional centers at Tokyo, Moscow and Nagpur and 20 laboratories in different countries.

PRACTICAL MEASURES

The practical steps that can be taken to reduce pollution are listed below:

- Modification of industrial process, whenever possible, to minimize air pollution by harmful chemicals.
- Use of electricity and natural gas in place of wood, coal and oil in houses and factories whenever possible.
- Use of alternative sources of energy (solar or wind energy, etc.) in place of conventional sources involving burning of fuel.
- Traffic management and reduction of pollution from vehicles by proper tuning of the engine.
- Health education of public about harmful effects of smoke and about methods of control (such as by proper burning of fuel, provision of chimneys, proper ventilation, etc.).
- Legal measures to control emission of smoke and other pollutants (such as Indian Factories Act, Smoke Nuisance Prevention Act, Indian Motor Vehicles Act and Industrial Zoning Order).
- Establishment of 'green belts' between industrial and residential areas.
- Issue of meteorological warning so that temporary steps may be taken during periods of high atmospheric stagnation.
- Cautious use of insecticides and pesticides.

Biological Agents in Atmosphere

Bacteria and viruses may pollute the air and may be carried to some distances along with dust particles. They may be inhaled or swallowed with water, milk or food polluted with infected dust. The chances of spread of disease in this way are remote because of great dilution and because of exposure to ultraviolet light in the open. This mode of infection may be responsible for wound infections with tetanus bacilli. It may also lead to inhalation of tubercle bacilli and scales of measles and chickenpox.

Ventilation

Ventilation implies exchange of vitiated air inside the room which is hot, humid and stagnant with

atmospheric air outside the room which is cool, dry and moving. The aim of ventilation is to ensure air supply inside the work place or living room in such a way that it is free from harmful agents and is conducive to comfort, efficiency and health.

USES OF VENTILATION

- The physical conditions of temperature, humidity and movement of room air are maintained constant. These conditions facilitate heat exchange from the skin to surrounding air or vice versa, depending upon the weather and season. In cold season one wants to gain heat and in warm weather one wants to lose heat. Ordinarily a man at rest weighing 70 kg loses 100 kilo cal heat and 40 ml moisture per hour.
- Smells and odors from the room are removed.
- Bacterial contamination of air in the room is reduced.
- Chemical composition of air inside the room is maintained constant, which is otherwise liable to change due to respiration, combustion and various industrial processes. A man weighing 70 kg breathes out 18 to 21 liters of carbon dioxide per hour. The concentration of oxygen and carbon dioxide is 20.96 and 0.03-0.04 percent in the fresh inspired air and 16.4 and 4.41 percent respectively in the expired air.

CAUSE OF ILL-EFFECTS IN UNVENTILATED ROOM

The old view was that the discomfort felt in a closed or congested room was because of chemical changes in the air, such as decrease of oxygen and increase of carbon dioxide, water vapor, bad odors and organic poisons emanating from human beings. Leonard Hill proved in 1914 that the sense of oppression in ill-ventilated rooms is caused not by chemical but by physical changes like rise of temperature, increase in humidity and stillness of air. He confined some students to a room. They felt quite comfortable even when oxygen content of air fell to 17 percent. On the other hand, he found that the oxygen level did not fall below 19 percent even in the most crowded rooms. Similarly, carbon dioxide never increases to more than 0.5 percent even in the most crowded place. Thus increase in carbon dioxide has nothing to do with the feeling of oppression in an ill-ventilated room.

The ill-effects in a congested room, (discomfort, restlessness, nausea, vomiting, irritability, giddiness, fainting, etc.) are currently believed to be due to the air becoming hot, humid, and stagnant, especially the air near the skin. This interferes with heat loss from skin. The net result is heat stagnation leading to the deleterious effects already described. If the same air is cooled, dried and then circulated, the discomfort and ill-effects are relieved. Congestion is not felt in cold weather because body can lose heat to cold air and to other objects in the room.

VENTILATION STANDARDS¹⁰

Though, as explained earlier, the feeling of comfort is associated more with physical factors determining heat loss from the body, the measurement of these factors as well as their summative effect upon the feeling of comfort is difficult. The kata thermometers and the concept of effective temperature have been developed for this purpose.

Cubic Space Per Person

Previously it was advocated that 3000 cubic feet space should be available per person. Now this recommendation is no longer followed, because it has been realized that floor area and air change are more important criteria.

Floor Area

It has been found that air movements occur mainly up to 3 to 4 meters above the floor. The air space higher than this is, so to say, dead space from the point of view of ventilation. Hence cubic space per person is not a reliable criterion, especially if the ceiling is high. A better index is floor area per person. The optimum floor space should be 5 to 10 sq meter per person. The exact figure would depend upon the degree of exchange of room air with outside air. Ordinary ventilation results in three air exchanges per hour, i.e. the room air is completely replaced by fresh air every 20 minutes. However, six exchanges per hour can be achieved by a suitable system of doors and windows without causing a draught. In that case the provision of floor space at the rate of 5 sq m per head would be adequate. Recommended standards of floor space per person in India are as follows:

Adults

Residential	5 sq m
Factory (as per Factories Act, 1948)	5 sq m
General hospital	10 sq m
Infectious diseases hospital	15 sq m

Schools

Space per child 0.8 sq m. The above air space standards are arbitrary and apply to ventilation in a room when it is taking place in warm weather and by natural methods only. These will not apply to cold and chilly whether. Even in warm climate the space required can be much reduced by use of fans and air conditioners with more exchange and cooling or air.

METHODS OF VENTILATION OR AIR EXCHANGE IN ROOM

These may be natural or artificial.

Natural Ventilation

This may be due to wind, diffusion or temperature difference. The effect of diffusion is rather small and slow. The main effects are those of wind and temperature.

Wind: The principal type of wind movement is *perflation*, which refers to movement of air across the room when doors and windows are open. It will perflate with higher velocity if there is cross ventilation, i.e. when two windows or doors are present opposite to each other. Some degree of air movement also occurs by *aspiration*. This occurs due to the suction effect at the tail end of a moving air column when it meets and bypasses an obstruction.

Temperature: This refers to movement of masses of air of unequal temperatures. Warm air rises up and goes through ventilators while cool air enters from below through the openings near the floor.

Artificial Ventilation

The following methods are used for this purpose:

Extraction or vacuum system: Exhaust fans are installed near the roof with the blades facing outwards.

Plenum or propulsion system: Fresh air is introduced in the room, often near the floor, through ducts or blowers. The commonly used air coolers or desert coolers are based upon this principle.

Combined extraction and propulsion system: This is used in congested halls and theatres where all natural inlets and outlets are closed.

Air conditioning: Several types of air conditioning are in use nowadays for artificial cooling or heating of air. Their aim is to ensure proper air flow, humidity and temperature. The air is first filtered and then saturated with water vapor. After removing excess moisture, air is brought to the desired temperature. The difference between the airconditioned air and the outside air is usually maintained at 5 to 8°C.

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Water is not only an environment but an essential requirement for life. Water purification was done as early as 2000 BC as mentioned in Sanskrit literature. The methods used were: (i) keeping water in copper vessels; (ii) exposing water to sunlight; (iii) filtering water through sand and gravel; (iv) boiling; (v) dipping hot iron in water. Provision of safe and adequate water to human populations is essential for health. Polluted water is known to have caused several epidemics of water-borne diseases in India, one of the most severe being the epidemic of infective hepatitis in Delhi in 1955 which was caused by contamination of water of the river Yamuna. The Government of India launched the National Water Supply and Sanitation Program in 1954 as an overall part of the National Health Plan. However, the achievements in this direction have been slow.

Only 77.7 percent urban population and 31 percent rural population in India was estimated to have safe drinking water supply in 1981.¹ The International Water and Sanitation Decade (1981-90) aimed at providing "Water for All" by 1990.

CRITERIA OF POTABLE WATER

The water is said to be potable when it is devoid of pathogenic agents, harmful chemical substances, and free from color, odor and usable for domestic purposes.

Sources of Water

Water Cycle

Approximately 97 percent of water being the salty sea water and 2 percent is frozen in glaciers and polar ice caps. Thus only 1 percent of the world's water is usable to human being and that as precious as life itself as lack of water (dehydration) kills as faster than lack of food (starvation).

Water evaporates from the sea and the land and forms clouds. The clouds precipitate into rain and thus water comes back to sea and land. Water falling on land remains upland or goes under ground by percolation. Thus, water sources can be divided into three categories:

1. *Rainwater*
2. *Surface water*
 - Ponds and tanks

- Natural lakes and impounded reservoirs
 - Rivers and streams
3. *Groundwater*
 - Wells: Shallow, deep, artesian
 - Springs: Shallow, deep, intermittent or seasonal, hot springs or sulfur springs.

It may be mentioned that sea water can also be used as a source of drinking water after desalination. The technology is presently very costly and is used only in a few oil rich Arabian countries.

It may be mentioned that 80 percent of water needs of rural India are met by groundwater and 20 percent from surface water. The situation is just the reverse in urban areas, where 80 percent needs are met by surface water and 20 percent from groundwater. It may be mentioned that 50 percent irrigation of the country is done with groundwater.

RAINWATER

Rainwater from roofs of houses may be collected and stored in small tanks below the ground in scarcity areas for future use. This is done in Dwarka (Gujarat) and Churu (Rajasthan). This water is soft and clean, but has to be protected against contamination. Rainwater is an important source of water in some countries like Indonesia and Gibraltar.

SURFACE WATER

This is basically rainwater that has collected on the ground. It is of three types as described below.

Ponds and tanks: These are the only water sources in some villages. These are used for drinking, bathing and washing by human beings and also for bathing of animals. This water is badly polluted and is the cause of water-borne diseases. In some cases wells are dug inside the tanks or by their side to obtain from them water reaching there by percolation. This water is safer than the pond water.

The methods of reducing water pollution of tanks and of obtaining safe water are listed as follows:

- Raising the edges of the tank to prevent entry of contaminated surface washings.
- Providing a fence around the tank to prevent the approach of cattle and other animals.

- Providing an elevated platform from where people can draw water from the tank. Direct entry of people into the tank should be prohibited. Guinea worm disease occurs because of direct contact between man and pond water.
- Cleaning the tank bed at the end of the dry season.
- Removing weeds periodically.
- Recent research² has indicated that tank water can be made safer if it is drawn through a *collecting well*, where the water collects after being made to pass through a sand bed along the side of the tank as shown in **Figure 6.1** slow sand filtration.
- Chlorination can be done to disinfect tank water.

Natural lakes and impounded reservoirs: Lakes are large natural collection of water. Impounded or artificial reservoirs are made by making dams across streams. They form a common source of water supply to large or medium sized towns such as Nagpur, Mumbai and Chennai. The purity of water in an impounded reservoir depends upon the type of catchment area. Natural purification takes place by ultraviolet light from sun and by sedimentation and storage but this cannot be relied upon. Water is usually supplied to towns after purification and disinfection by artificial means.

Rivers and streams: These form a major source of water supply. People take water directly from this source in the belief that running water is safe. However, rivers may be polluted by human and animal excreta, refuse and sullage water, etc. discharged into them. Natural purification does take place to some extent (through sedimentation, dilution, oxidation, aeration, ultraviolet rays, sunlight and the action of aquatic plants and animals) but this may not be sufficient to render it safe for drinking. Hence river water is supplied to the cities after passing through purification plants.

River bank near the village may be marked into 5 divisions for safer supply. Limits of each division may be indicated by flags from upstream to downstream for different uses—drinking, bathing, washing of clothes and utensils; watering of animals, and bathing of animals, in that order.

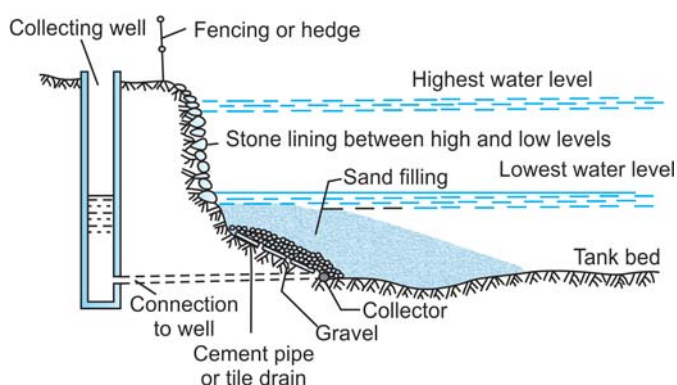


Fig. 6.1: Tank with collecting well (slow sand filtration)

GROUNDWATER

Rainwater percolates through the ground or soil. As subsoil or under groundwater, it is present in the whole of the porous mass. Further percolation stops when an impermeable stratum is encountered. A porous mass with lot of water, supported by an impervious rock or formation such as chalk, limestone, sandstone, millstone, grit, etc. is called *water-table*.

Porous and rocky formations do not occur in straight lines; water percolates down at some places, through the soil above, beyond an impervious layer. Thus there may be second, third and even fourth water tables, separated by impervious layers. The quality of subsoil water drawn by wells, tube-wells or springs depends on the nature of the formation on which it rests and the number or depth of the water-table from the surface.

Groundwater is obtained from wells and springs. These are described below:

WELLS

Wells are a very common source of water supply in India. They are of three types—shallow wells, deep wells and artesian wells. The wells, whether shallow or deep, may be of two types, viz. open wells and tube-wells. An *open-well* is a pit dug out in the ground to reach the water level. Water is obtained through a rope and bucket. Sometimes a hand-pump or motor pump may also be installed in an open well. A *tube-well* is a bore hole with a tubing through which water is obtained with the help of a pump. As per this definition, an ordinary hand-pump is also a tube-well, but in common usage the term tube-well implies a pump operated through a motor.

Shallow well: The terms shallow and deep well do not refer to the actual depth of the water level from ground. They refer to the water table as defined earlier. A shallow well draws water from the first water table which is near the surface. Such a well may be polluted by bacteria and other impurities which percolate down along with rain or spill water. Some natural purification takes place through the porous soil (which acts as a filter) and through the action of soil bacteria. Shallow well is the most common source of water in the villages. Continuous disinfection (by bleaching powder, for example) is necessary to have safe drinking water from shallow wells.

Deep well: It draws water from the second or a deeper water-table. This water is much cleaner and bacteriologically safer, but is often hard because of a high mineral content. The minerals (calcium and magnesium carbonates, sulphates and chlorides) are derived from the limestone formations. Deep wells may be sometimes several hundred feet deep depending upon the location of the impervious layer. The quantity of water that can be drawn from a deep well is usually more than that available from a shallow well, which may dry up after a few

years of use. Deep tube-wells are often used as a source of city water supply. In Delhi, many tube-wells are used to supplement the water supply from Yamuna river. In Chandigarh, the entire city water supply is obtained from deep tube-wells.

Artesian well: The water source for percolation in this case is at a very high level. The impervious table sloped down to some place much lower down and water is held up under pressure between the two impervious tables. When a tube-well is sunk at such a place, the water gushes out with force. The water is variable in nature and may be cold or warm, soft or hard. Artesian wells are not common in India. Some are found in Gujarat in Viramgam and Dholka Talukas in Ahmedabad, Harij in Mehsana and Radhanpur Taluka in Palanpur.

Stepwell: Stepwells are mainly found in the desert areas of Gujarat and Rajasthan, some descending by as many as 170 steps and 46 meters to reach the water. Here monsoon rain is caught in a depression or behind a hand-built earthen dam. The rainwater percolates down through fine silt, which screens out particulates, until the water reaches an impermeable layer of compact clay that keeps it from sinking deeper into the ground. In that way the muddy runoff of the monsoon is stored near the surface as a giant sheet of clear water: an underground aquifer.

When the water level is high, during the monsoon, the visitor descends only a few steps to drink or bathe or fill the household vessel; when the water is low, one has to descend further, as deep as nine stories down, to get the water.

Public health implications: Cyclops which harboured guinea worm disease was abundant in stepwell water. A stepwell was host not only to human beings but also to entire community of bees, fishes, lizards, parrots, pigeons, and turtles, which helped in spreading of different diseases.

SANITARY WELL

A sanitary well is one which is so located and constructed as to provide adequate prevention from contamination and pollution of water. Since wells form the most common source of water in the rural areas, it is important to know in detail the sanitary measures for making the well water safe (**Fig. 6.2**). These measures are described below as primary and secondary measures. It is important for the PHC medical officer to know these even today.

PRIMARY MEASURES

- A pucca brick casing resting on a wooden circular plate, lined inside by cement plaster entirely and on outside up to about 1.75 meter or so, fortified by ramming with clay.

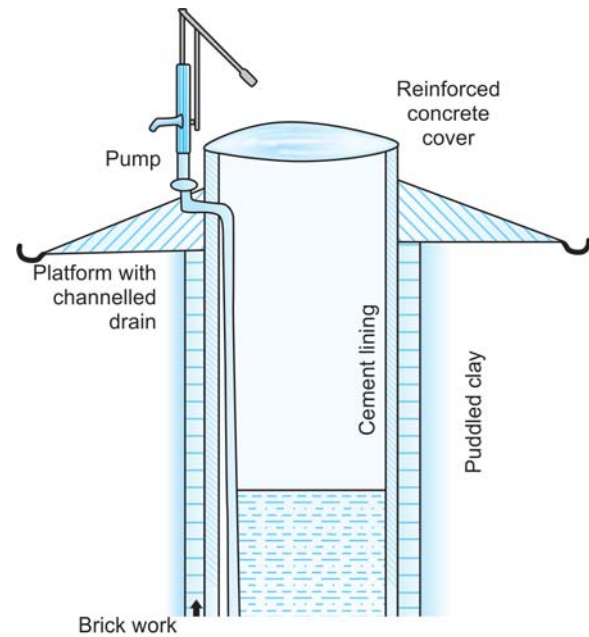


Fig. 6.2: Protected well

- A parapet wall 0.5 to 1 meter high with cement lining on both sides and sloping outwards on top.
- A pucca cement concrete surrounding platform 0.5 to 1 meter wide and sloping towards the periphery.
- A circular drain around the platform, to receive spilled water.
- A drain 15 to 30 meters long ending into a soakpit, garden or a field.
- Drawing water arrangement—A common bucket should be used which can be pulled using a pulley or a wheel with handle. It is preferable to instal a hand-pump or a motor pump if possible.
- The well should be properly covered. This markedly improves the bacteriological quality of water.³ Covering the well also prevents sunshine, thus checking the growth of algae and fungi in water.
- There should be no trees nearby. Tree leaves may fall into the open well. Besides, growth of trees nearby may cause cracks in well wall.
- Distance from privy, cesspool, soakpit, drain, or manure heap should not be less than 15 meters.
- The well should not be so low as to be subject to flooding by rain water or to washing in of surface impurities from the surroundings.
- A deep well is preferable as it is less likely to be polluted.

SECONDARY MEASURES

- A pucca washing place away from the well for washing of clothes so that no washing is done on the surrounding platform.
- A bathing shed or bathrooms near the well, to prevent people from bathing on the surrounding platform.
- A platform with a drain to clean utensils at a distance of 2 to 3 m.

- Tank for watering animals at a distance of 5 to 6 meters.
- A sloping platform for washing and bathing of animals near the watering tank. It should have a gutter to receive the waste water.
- Regular chlorination (at least once a week ordinarily, twice a week in rainy season and daily when there is threat of an epidemic). This ensures bacteriological safety.

WATER QUANTITY, YIELD AND AREA OF DRAINAGE

The quality of water in a well is required to be measured to know how much of bleaching powder is to be added for disinfection. This can be found by multiplying the surface area of water column by its depth. The appropriate formula would be:

$$\begin{aligned}\text{Quantity of water} &= \pi r^2 \times W \text{ cubic meters} \\ &= \pi r^2 \times W \text{ 1000 liters}\end{aligned}$$

$$\text{where } \pi = 3.1416$$

$$r = \text{Radius in meters}$$

$$W = \text{Depth of water in meters}$$

A little arithmetical manipulation gives the following formula:

$$\text{Quality in liters} = \text{Square of diameter in meters} \times \text{Depth in meters} \times 785$$

The *Yield of Water* per day is the quantity of water that can replace the water drawn from the well. This is found by pumping the well empty and then noting the depth of water column that accumulates after 24 hours. The quantity of the water that has accumulated, or the yield, is then calculated by the formula given above. For estimating the area of drainage of a well, the base of the well may be considered as the apex of a conical zone of filtration. The radius of this cone is 3 to 4 times the depth of the well. Thus if a well is 10 meters deep, its area of drainage is within an area of 30 to 40 meters radius around the well. This should be kept in mind in relation to a latrine or other likely source of pollution near the well.

Sometimes it may be necessary to confirm whether pollution is reaching the well from a particular suspected source. This can be done by putting a solution of fluorescein or Rhodmin B in the suspected source of pollution and looking for the dye in the well water. Detection can also be done by adding chromobacteria to the suspected source. An example is *Chromobacterium prodigiosum* which can be easily identified by its red colonies.

Periodic cleaning of wells is necessary for maintaining the quality of water. The base of the well should be dislodged or distilled at least once in a year. This improves not only the quality but also the quantity of water.

Hand-pumps

Water from a hand-pump is safer than that from open wells. It is the government's endeavor to provide hand-

pumps in all villages. When that happens, there will be no need to retain in this book the detailed description of a sanitary well given above.

The ordinary hand-pump made of cast iron is designed for only limited depth. It has several deficiencies such as how discharge, greater manual effort, possibility of contamination and shorter lifespan. These defects were removed in the *India Mark II* pump developed in India with support of UNICEF. It is made almost entirely from steel and is galvanised, making it sturdy and long-lasting. It also has excellent built-in mechanical efficiency so that even children can operate it easily upto a depth of 30 meters. It is also totally sealed from external contamination. Its simple design makes it easy to produce even in small factories. Quality control is ensured through its standardization by the Bureau of Indian Standards (ISI No 9301). More than 1.5 million Mark II pumps have been installed in India. Several thousand have been installed in many other countries of Africa, Latin America and Asia.⁴ However, its maintenance and repair are not easy at village level. In order to remove this drawback, two optional designs, have emerged: (a) The India Mark II (modified) Deep well Hand-pump and; (b) The India Mark III VLOM (Village Level Operation and Maintenance) Deep-well Hand-pump.

The *India Mark III (VLOM) Deep-well hand-pump* (ISI: 13056) is made of very strong materials and seldom breaks down. All the parts are checked and tested so that they fit together perfectly. This hand-pump can be maintained even by village women themselves, with little training, using simple tools. Therefore India Mark III (VLOM) Hand-pump is more suitable for village level operation and maintenance. Its main feature are:⁵

- Easily maintainable by village communities requiring minimum skills, training and tools.
- Robust and reliable under field conditions.
- Cost effective, and
- Greater mean time before failure (MTBF).

Springs

They are formed by groundwater flowing over to the surface when an impervious formation comes near the surface of earth. Springs are cheap, clean and usually safe source of water supply for small communities in the hills. The point at which they issue has to be protected from contamination. They may be shallow or deep as per the same criteria applicable in case of shallow and deep well. Springs are not a major source of water supply in India.

Water Supply and Quantitative Standards

It is desirable to have piped water supply for all communities for proper health and cleanliness. It is a must

for large communities. Such supply should be adequate, wholesome and safe. The layout of water pipe schemes and their working is entirely in the hands of public health engineers. A water supply system consists of three components: the source of water, the waterworks refers to the purification plant where water is purified and pumped to a tank at a higher level, often known as service reservoir, where a water-head of 6 m is maintained above the highest building. From service reservoir, water goes by gravity to the city from which service pipes branch out for various streets and buildings.

Individual water needs differ widely depending upon habits, climate etc. Approximate requirements for various purposes are given below in liters per capita per day.

Use	Liters
Domestic	
Drinking	1.5
Cooking	3.0
Cleaning utensils	15.5
Washing	5.0
Bathing	35.0
Flushing of latrines	15.0
Laundering	15.0
Total	90.0
Public	
Street washing, flushing of sewers, watering of public parks and gardens, building construction and fire fighting	25.0
Industrial and commercial use	25.0
Animal use	10.0
Grand Total	150.0

The above requirements add up to 150 liter per day. Allowing for an excess margin of 20%, the Environmental Hygiene Committee of Government of India recommended provision of water at the rate of 180 day for large communities and at a lesser rate for smaller communities as given below.⁶

Population	Quantity per head (without sewerage)	Quantity per head (with sewerage)
1,000-5,000	60 liters	80 liters
5,000-20,000	80 liters	100 liters
20,000-50,000	100 liters	120 liters
50,000-2,00,000	160 liters	180 liters
Greater than 2,00,000	180 liters	180 liters

National drinking water requirements have been targeted at 40 liters per capita per day in rural areas and 110 liters in urban areas. The requirement in Chennai and Hyderabad has been fixed at 140 to 170 liters and in Delhi at 270 liters per capita. Delhi gets only half this amount at present. In comparison, per capita consumption of drinking water in US cities is 540 liters.

As pointed out by the World Bank, as much as 40 percent of the per capita water supply in urban areas is used for no useful purpose other than flushing away wastes.⁷ The water needs for a community would thus be almost halved if alternative appropriate technology

is used for waste disposal. Efforts are being currently made to develop such technologies.

Water Quality and Qualitative Standards^{8,9}

Water is an immediate environment of the human host. It may harbour many harmful agents that may produce a state of disease. Such agents may be biological, chemical or physical, as described below. Water pollution is further discussed in the chapters on environmental pollution.

Biological

- **Viruses**—Examples are viruses of infective hepatitis, poliomyelitis and Cocksackie group which enter water when it gets polluted with stools or sewage.
- **Bacteria**—These cause dysentery, typhoid, paratyphoid, cholera and food poisoning. Tularemia and anthrax have also been transmitted through water. *Leptospira icterohemorrhagiae*, passed in urine of rats, may also pollute water.
- **Protozoa**—Cysts of *Entamoeba histolytica* and giardia.
- **Worms**—Ova of roundworms may pollute water coming in contact with polluted soil. Water can also be a vehicle for transmission of guinea worm and trematodes.

Chemical

- **Excess of soluble salts** like sulfates may cause diarrhea. Hardness due to sulfates and chlorides of calcium and magnesium may cause digestive upsets. Fluorides in excess may cause symptoms of fluorosis. Fluorine and iodine deficiency may be associated with caries and goitre respectively.
- **Lead or other metals** such as iron, zinc and copper may cause poisonous symptoms. **Insoluble matter** such as sand, clay and mica may cause irritative diarrhea when present in excess.
- **Insecticides** used in agriculture may pollute water and cause poisoning.

Physical

Water containing radioactive wastes may be hazardous to health.

Standards of Quality

These may be classified as physical, chemical and microbiological standards, as described below.

PHYSICAL STANDARDS

Wholesome water should be odorless, tasteless and clear without any turbidity.

Color

A large collection of water may be apparent as pale blue or pale green, otherwise water is colorless. However, it may be reddish when iron salts are present in it. A dilute solution of K_2CrO_7 and cobalt sulfate in the tintometre is used to measure the color. There is a standard series or colored tubes. The color of good water is 0.5 on Hazen scale. It should not be more than 5 units as per the platinum cobalt scale.

Odors

They are imparted by algae and organic and mineral matter that reaches water through seepage or from industries. Algae give a fishy or putrescent odor on decomposition. Tar, peat and gases impart their typical smells. No disagreeable smell is permissible in portable water.

Taste

A pleasant taste is due mainly to dissolved O_2 and CO_2 . That is why boiled, distilled or rainwater has a flat or insipid taste. The taste can be regained by shaking. Well water may sometimes be brackish in taste.

Reaction

Sour taste is due to acids (excess of CO_2) and bitter taste is due to alkalies (such as ammonia) from decaying organic matter like dead animals, leaves, rotten wood and dead marsh plants. pH should be 7 to 8.5.

Turbidity

It is due to fine particles of mud, sand, slime, clay, loam, and organic matter and a large variety of aqueous microorganisms including plantation suspended in water. They settle down by storage or on adding alum. Turbidity can be measured by Jackson-Candle turbidimeter. The permissible limit is up to 5 units.

Radiological Quality

Increasing pollution of water sources¹⁰ with radioactive wastes from nuclear reactors has become a problem during recent years. Another source is the radioactive debris from nuclear fall out. This debris, usually from a nuclear detonation, is deposited on the earth after having been blown by the winds. International standards for the upper limit of radioactivity in water are as follows:

- Gross alpha activity—3 picocurie/l
- Gross beta activity—30 picocurie/l.

CHEMICAL STANDARDS

The WHO had laid down water standards under three categories.⁸

Toxic Substances

These are lead, selenium, arsenic, cyanide and mercury.

Substances that may Affect Health

- **Fluorine:** It should be present in a concentration of 0.5 to 0.8 mg/l to prevent caries. Concentration less than 0.5 mg/l is associated with caries in the population. Excess fluoride (more than 1.5 parts per million) causes chalky discoloration of teeth, seen first on incisors as transverse patches. Levels above 3.5 PPM may be associated with skeletal fluorosis. High fluoride content has been found in Punjab (up to 44 PPM and beyond), Andhra Pradesh, Tamil Nadu, Kerala and Junagadh district of Gujarat.
- **Nitrates:** Some water samples may be too rich in nitrates. Amounts in excess of 45 mg/l (as NO_3) may cause methaemoglobinemia in infants. No harmful effects are seen in adults.
- **Polynuclear aromatic hydrocarbons (PAH):** These may be carcinogenic. They should not be present in water in excess of 0.2 mg per liter.

Substances that may Affect Water Acceptability

These include—iron, calcium, copper, zinc, etc. Their presence affects water acceptability due to changes in color, taste, etc.

The levels of various chemical substances permissible in drinking water have been given by WHO⁸ as “highest permissible levels” and by Indian Standards Institute^{9a} as “desirable upper limit”. These are shown in **Table 6.1**.

Besides the above, other BIS standard for drinking water (upper limit) are: Color (10 Hazen units), Turbidity (10 NTU), pH (6.5 to 8.5).

It may be mentioned here that tube-well water in some parts of Delhi has excessive levels of iron and chlorides. It is also too hard in some areas.

Hardness of Water

Water is said to be hard when it destroys soap because of the dissolved salts. These salts are bicarbonates, sulfates and chlorides of calcium and magnesium. The hardness due to the presence of bicarbonates was earlier labelled as *temporary hardness* as compared to *permanent hardness* due to other salts. These terms are no longer used now. Hardness is expressed as milliequivalents per liter of the hardness producing ion. Thus a sample of water having 50 mg of calcium carbonate per liter would have 1 mEq/L of hardness.⁸ Water can be categorized as soft or hard as follows:

	mEq/L
Soft	0-0.9
Moderately hard	1-2.9
Hard	3-5.9
Very hard	6 and above

TABLE 6.1: Chemical standards for water

		WHO	BIS
• Toxic substances			
Lead	(as Pb)	0.05	0.1
Selenium	(as Se)	0.001	0.01
Arsenic	(as As)	0.05	0.05
Cadmium	(as Cd)	0.005	0.01
Cyanide	(as Cn)	0.05	0.05
Mercury	(as Hg)	0.001	0.001
• Substances that may affect health			
Fluoride	(as F)		0.6–1.2
Nitrates	(as NO ₃)		45
• Substances that may affect acceptability			
Iron	(as Fe)	0.1	0.3
Calcium	(as Ca)	75	75
Copper	(as Cu)	0.05	0.05
Zinc	(as Zn)	5	5
Manganese	(as Mn)	0.05	0.1
Magnesium	(as Mg)	30	30
Total dissolved solids		500	500
Chloride	(as Cl)	200	250
Sulfate	(as SO ₄)	200	150
Phenolic substances	(as C ₆ H ₅ OH)	0.001	0.001
Total hardness	(as CaCO ₃)	100	300
Mineral oil			0.01
Residual free chlorine			0.02

NB—All values are in mg/liter. BIS = Bureau of Indian Standards

Too soft water is insipid in taste. Drinking water should be preferably moderately hard.

Hardness is objectionable for the following reasons:

- Hard water precipitates soap forming curds. Hardness causes wastage of soap and difficulty in laundering, bathing and hair washing.
- Hard water affects the durability of textiles.
- Hard water causes encrustation in boilers and utensils which might crack on sudden heating. Encrusted utensils require more fuel for heating. Hard water also causes scaling, encrusting, occlusion and bursting of water pipes.
- Hard water is unsuitable for certain industries.

There is no conclusive evidence that hardness affects health. Some people get digestive upsets when they are not used to hard water. On the other hand, coronary artery diseases has been found to be more common in areas with soft water supply. This has been attributed to magnesium deficiency.¹¹

MICROBIOLOGICAL STANDARDS

Ideally, drinking water should not contain any micro-organism at all. This ideal is unattainable. Natural waters contain various types of bacteria that may be saprophytes, coliforms (typical, atypical and intermediate atypical coliforms, IAC) and pathogens for cholera, typhoid, dysentery, etc. The main aim of testing for water quality is to look for the presence of coliform

bacteria in water to know whether water is being polluted by human excreta which may contain pathogens. Most authorities now insist that water should be free from all sorts of *E.coli* as well as fecal streptococci. The WHO has recommended the following criteria of safety for large water supplies:

- No sample should have *E.coli* in 100 ml.
- No sample should have more than 3 coliforms per 100 ml.
- Not more than 5 percent samples throughout the year should have coliforms in 100 ml.
- No two consecutive samples should have coliform organisms in 100 ml.

The above standards may have to be relaxed in case of small water supplies from wells, etc. In such cases isolated samples should not have more than 10 coliforms per 100 ml. Persistent presence of coliforms, especially of *E.coli*, would indicate that the water is unsafe for drinking.

While detailed microbiological techniques are to be found in appropriate textbooks, a brief description of the method used for surveillance of water quality is given here. These methods are of four types: presumptive coliform test, colony count, test for fecal streptococci and *Clostridium perfringens* and tests for pathogens.

Presumptive Coliform Count (Multiple Tube Technique)

It is done on lactose bile salt medium (MacConkey's broth), which is a selective medium for coliform bacteria which produce acid and gas. Acid is indicated by the medium turning red. Gas gets collected in the Durham's tube.

Method: Sterilize 16 tubes containing single or double strength MacConkey's fluid medium. Add different quantities of water to be tested as follows:

- 50 ml water to 50 ml double strength medium in one tube.
- 10 ml water to 10 ml double strength medium in each of 5 tubes.
- 1 ml water to 5 ml single strength medium in each of 5 tubes.
- 0.1 ml water to 5 ml single strength medium in each of 5 tubes.
- Incubate for 48 hours and read the result.

The probable number of coliform bacilli per 100 ml of water is found by referring to McCrady's table. It is called presumptive count because the actual number of organisms in the sample of water is not counted. It is presumed that each of the tubes in the test showing fermentation contains coliform organisms.

Further confirmation of the type of coliform organisms is done by the Eijkman's test. In this test the typical fecal *Escherichia coli* are differentiated from nonfecal coliforms by incubating the tubes at two different temperatures, viz., 37°C and 44°C. The *E. coli* grow at 44°C while the other coliforms do not.

Colony Count

The aim here is to have an estimate of the general microbiological quality of water. The standard count involves inoculating nutrient agar plates with 1 ml water and inoculating them at two different temperatures—22°C for 72 hours and 37°C for 48 hours. The number of colonies is then counted. The growth at 22°C indicates the presence of saprophytes. The following guidelines for safe water are used for interpretation:

Disinfected water—Plate count 0 at 37°C and upto 20 at 22°C.

Undisinfected water—Plate count up to 10 at 37°C and not more than 100 at 22°C.

A high total count at 22°C has no value. However, sudden changes from low to high may indicate pollution. Uncontaminated well water may have a total count of 100 to 200 per ml. Surface waters have high count, especially after rains, while groundwaters usually have a low count.

Fecal Streptococci and Clostridium Perfringens

Since these bacteria are of fecal origin, their presence may be looked for and may provide confirmatory evidence when fecal pollution of water is suspected but is doubtful.

Pathogens

When indicated, specific tests may be performed to look for the presence of pathogenesis like *Vibrio cholerae*.

Some chemical criteria are also useful for determining the microbiological quality of water. These are described below:

AMMONIA

Free and saline ammonia is produced on decomposition of organic matter, hence its presence indicates organic or sewage pollution of recent origin. It should not be present in excess of 0.005 mg/l. *Albuminoid ammonia* indicates the presence of undercomposed organic matter. Its upper permissible limit is 0.01 mg/l. It is absent in under groundwaters.

NITRITES

These indicate recent pollution, except in deep well water, where it might be formed as a result of reduction of nitrates by ferrous salts. Nitrites should be absent in water. Water containing more than a trace should be suspected to be polluted.

BIOLOGICAL OXYGEN DEMAND OF WATER

The amount of organic matter present in water is indicated by the amount of oxygen absorbed by it. The amount absorbed by one liter of water in 5 minutes should not exceed 0.1 mg. The amount absorbed in 4 hours should not exceed 0.5 mg.

DISSOLVED OXYGEN

Low levels of dissolved oxygen in water indicate that it contains organic matter. Dissolved oxygen should not be less than 5 mg/l.

Collection of Water Samples

For physical and chemical analysis, about 2 liters of water is collected in a Winchester bottle after it has been rinsed twice. The bottle is stoppered and sent to the laboratory. In case of a tank or river the sample should be taken 1 to 2 meters away from the shore without disturbing the mud and should be filled from below the surface. From a well, the sample should be taken after the day's pumping is over. While collecting from a tap the sample should be taken after letting the water run off for some time.

For bacteriological analysis a 230 ml sterilized bottle with a glass stopper, covered with a rubber cap, is taken. The bottle is packed in ice and sent to the laboratory within 6 hours. The following details about the source of water should be forwarded with the sample for the opinion of the expert:

- Date and time of collection
- Purpose of analysis
- Source of water and address
- Nature of soil and source of pollution, if any, with distance
- Condition of the well and the method of drawing water
- Recent rainfall or flood
- Any existing water-borne disease
- Any other particulars.

Purification of Water

Water has to be treated before use in such a way that it conforms to the prescribed standards and is free from harmful agents as far as possible. Such treatment may be carried out at large, medium or small (domestic) scale as described below.

Purification on Large Scale

This is carried out in the following stages:

- Storage
- Filtration
- Chlorination.

STORAGE

This is an important step in purification. Up to 90 percent of suspended matter settles down within 24 hours of storage. This allows penetration of more sunlight which has its own sterilizing effect. The bacterial content decreases markedly, the colony count decreasing to about 10 percent of the initial level within a week. Some more fall occurs during the second week. Storage beyond two weeks may be associated with growth of algae, hence it is not

recommended. The chemical changes during storage include a fall in free ammonia and a rise in nitrates because of the oxidising action of aerobic bacteria upon organic matter.

FILTRATION

On a large scale, filtration was started in the beginning of 19th century. There are two types of filters.

1. Slow sand filter, biological filter or English filter.
2. Rapid sand filter, mechanical filter or American filter, which is again of two types: Paterson filter (Gravity filter) and Candy filter (Pressure filter). The slow sand filter was the one used initially. Nowadays the rapid sand filter is also in common use.

Slow Sand Filter¹²

The slow sand filter essentially consists of four elements:

- Water head, which is a layer of raw water 1 to 1.5 meters deep.
- Sand bed (1.25 meter thick, composed of sand particles 0.15 to 0.35 mm in diameter), supported on a layer of fine and then coarse gravel.
- Drainage system for filtered water consisting of perforated pipes.
- Filter control valves in the outflow pipe with the help of which the outflow of water is regulated in such a way that a constant water head of 1 to 1.5 meter is maintained. The first three elements together constitute the filter box, which is an open rectangular box 2.5 to 4 meters deep. The different layers in the filter box from bottom upwards are listed below (**Fig. 6.3**).

Drains at the bottom with perforations	5 cm
Layer of bricks with gaps	10 cm
Small stones about 1 cm in size	10 cm
Gravel pieces about 0.5 cm in size	10 cm
Fine sand (coarse sand in case of rapid sand filter)	75 cm
Water head above the sand	150 cm
Total	3.6 meters

Within 2 to 3 days after the fresh sand layer is laid down, a slimy *vital layer or filtering membrane* is formed at the top of the sand bed. This consists of multiple forms of microorganisms, including bacteria, diatoms, plankton and algae embedded in silt and organic matter. This biological layer helps in purifying water by holding back bacteria and by oxidising the organic matter. The formation of the biological layer is referred to as ripening of the filter. When fully formed, it is 2 to 3 cm thick. When this becomes too thick, it has to be scraped. The new layer takes 24 hours to develop, during which period proper filtration cannot occur and the filtrate has to be discarded. Thus the slow sand filter does not permit continuous water supply.

The rate of filtration through slow filter is 0.1 to 0.4 cubic meters per sq meter of surface per hour. Water

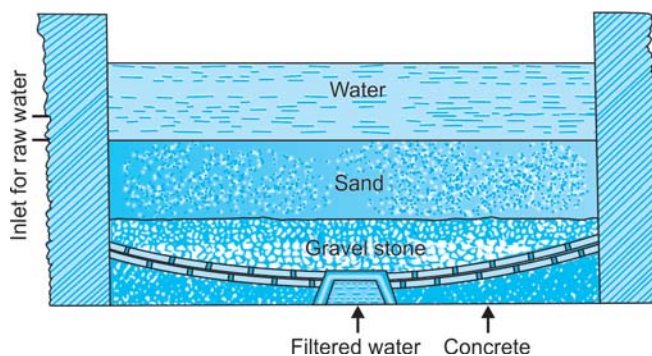
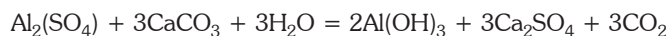


Fig. 6.3: Section of slow sand filter

takes about 2 hours to pass through the slow filter. One cubic centimeter of sand in the filter bed provides 150 sq cm surface area to the water passing through it.

Rapid Sand Filter

This is the filter commonly used nowadays. Before the water comes to the filter it is subjected to a process of coagulation. The coagulant used is alum in a dose of 5 to 80 mg per liter depending on turbidity. In the presence of calcium carbonate, alum forms 'floc' as per the following reaction:



The floc is a flocculent precipitate of aluminium hydroxide which clarifies the water. It entangles all particulate, suspended and colloidal matter along with bacteria and forms 'floc' balls' which, being heavy, settle down to the bottom. Thus the bacterial content of water decreases and any undesirable colour and odours are removed or reduced.

As the water enters the purification works from the raw source, it is mixed rapidly and thoroughly with alum in the mixing chamber. From there it goes to a flocculation chamber where it rests for half an hour. During this period, it is gently stirred with the help of slowly rotating paddles. As a result, a copious precipitate of aluminum hydroxide forms. Next, the water moves to the sedimentation tank. Here the puffy balls of floc settle down along with the bacteria and suspended matter. The water rests in the sedimentation tank for 2 to 6 hours. The clear water above the precipitated sludge now goes to the filter bed.

The filter bed in rapid sand filter is essentially similar to that in the slow sand filter, with two differences. Firstly, the sand is coarser (diameter 0.6-2 mm). Secondly, the biological membrane is replaced in the rapid filter by the layer of "alum floc" which escapes settling in the sedimentation tank and is held at the top of the sand bed as a slimy layer capable of holding back bacteria. When this layer becomes too thick, there is "loss of head", i.e. the water level above the filter bed rises due to slowing of filtration. The filter is then back washed by agitating the sand by bubbling of air from below in the reverse direction. After back washing the slimy layer again forms within 5 minutes. The total time

taken for revitalization (back washing plus settling of fresh slimy layer) is only 15 minutes. Thus it is almost a continuous process unlike the slow filter, where the period of interruption is at least 24 hours. The rate of filtration in a rapid filter is 4000 to 7500 liters per sq metre per hour as against 100 to 400 liters per sq metre in case of slow sand filter. Similarly, the downward velocity of water is 400 to 7500 cm per hour in the former and 10 cm per hour in the latter.

The slow filter removes 99.9 percent of bacteria as against 98 to 99 percent in case of rapid filter, but this is of little consequence, especially when filtration is followed by chlorination.

CHLORINATION

Chlorination has numerous functions in water treatment besides disinfection. It acts as an oxidant and an aid to coagulation, controls odors and tastes, suppresses biological growths in transmission mains and maintains residual disinfection to protect the distribution system. Chlorination is the method of choice for sterilization of water on a large scale. It is the cheapest and most reliable method. Liquid chlorine in steel cylinders or drums is available for this purpose. The cylinder is fitted with a mechanical device (chloronome) that regulates the dose of chlorine. It is first mixed up with a small quantity of water and then added to the flowing water. Chlorine acts on water in the following ways:

- It combines with chemicals like iron, magnesium and H_2S , etc. to form chlorides.
- It forms hypochlorous acid ($HOCl$) which is responsible for the disinfectant action.
 $H_2O + Cl_2 = HOCl + HCl$
 The hypochlorous acid further breaks to produce hypochlorite ion.
- If there is any free or albuminoid ammonia in water, chlorine combines with it to form *chloramines* as below:
 $NH_4OH + Cl_2 = NH_2Cl$ or $NHCl_2$ or $NCl_3 + H_2O$
 The mono, di or tri chloramines have slow but prolonged germicidal and bacteriostatic action. They prevent growth of algae and fungi in tanks and reduce colors and odors. They get destroyed on prolonged contact.
- Free or residual chlorine remaining in water acts as a powerful germicide, killing pathogenic bacteria (but sparing spores, cysts, ova and viruses of polio and viral hepatitis, except in high dose). It should be ensured for proper chlorination that 0.5 mg chlorine per liter of water is present after 1 hour contact in residual chlorine.¹³

The action of chlorine depends on:

- Contact time
- Organic matter, metals and bacterial content
- Temperature and pH; Chlorine is less effective at low temperature and high pH

- Amount of free or residual chlorine or chloramines.

Chlorine demand of filtered and natural waters, otherwise clean, is usually not more than 1 PPM. One to two kg liquid chlorine is needed for one million liter of water. The dose has to be adjusted as per the demand.

The usual method of chlorination for large water supplies is the *break point chlorination*. Break point is that point of time when, as chlorine is added to water, its chlorine demand is met and free chlorine starts appearing in water. Chlorine demand is the amount of chlorine needed to kill bacteria, to oxidise organic matter and to neutralise the ammonia present in water. The principle of break point chlorination is to add sufficient chlorine so that 0.5 PPM free chlorine is present in water after break point has been reached.

Sometimes chlorination is done by ammonia-chlorine process or chloramination. In this process ammonia is added first, followed by chlorine. The latter exerts its rapid bactericidal action and then combines with NH_3 to form chloramines. Long contact of at least 2 hours is necessary for chlorine to kill bacteria. Thus it is suitable in case of a swimming pool where enough time is available and prolonged action is required.

In case of highly polluted waters the preferred method of chlorination is *superchlorination* followed by dechlorination. In this method a high dose of chlorine is added. After about 20 minutes contact, dechlorination is done with sodium sulphate or sodium thiosulphate to reduce chlorinous taste. This method is suitable for wells and ponds heavily infected or suspected to contain infectious agents not killed by ordinary chlorination such as the viruses of polio and infective hepatitis, cysts of *Entamoeba histolytica*, cercariae of schistosomes and cyclops.

Chlorination of water gives rise to several chlorine compounds, whose nature is not fully understood. Some of these may be carcinogenous. Many of these belong to the category trihalomethanes, the total quantity of which in drinking water should not exceed 100 mg/l as per current US federal standards. Chloroform, a potential carcinogen, is one of these trihalomethanes. People who drink water containing chloroform as a result of chlorination run a one in ten million chance of developing cancer in their lifetime.¹⁴ The WHO has set a recommended limit of 30 mg/l for chloroform in drinking water.¹⁴

ALTERNATIVES TO CHLORINATION

In view of the slight risks associated with chlorine, economically developed countries use the following alternatives to a variable extent.

Chlorine Dioxide

It is an industrial bleaching agent, also used widely in water treatment plants for taste, odor and algae control, as also for removal of iron and manganese.⁶ In Europe, it is used for disinfection also. It is a highly effective biocide against bacteria and viruses and leaves a residual.¹⁴

Chloramine

Free aqueous chlorine is applied as a primary disinfectant for an hour or so, and then ammonia is added to form chloramine as residual disinfectant and inhibit further formation of haloforms—and presumably other chlorinated organic compounds—in the distribution system. In naturally ammonia-rich waters simply adding chlorine will produce chloramines.

Chloramine appears to be less effective than chlorine in preventing nuisance growths in pipes, causing unsightly filamentous sediments at consumer taps. For the same reason, the odorous secretions of algae, which are not killed by chloramine, may persist. Also, chloramine is not a strong enough oxidant to remove the odorous products of decaying vegetation.

Ozone

Widely used in Europe and Canada as a primary treatment technique, the technology of large scale ozone plants is well established. Ozone generation from air or oxygen requires a large power source and cooling, for which relatively complex equipment is needed. Ozone is a strong oxidizing gas. It reacts rapidly with most organic molecules. Its short half-life in water, approximately 10 to 30 minutes, requires it to be generated on site, and it does not produce a residual, so a second disinfectant must be added to give the necessary protection in the distribution system.

Ultraviolet Light

UV radiation can be applied to water to kill microorganisms. However, water must have low turbidity because particulate matter adsorbs radiation. UV radiation technology was first developed for small private water systems, but has recently been applied successfully to a municipal system in the UK.¹⁴

TESTS OF FREE CHLORINE

Orthotolidine test: It is done to find the presence of both free chlorine and chloramine in water. On addition of the reagent (analytical grade orthotolidine dissolved in 10 percent of HCl) immediate development of yellow color indicates free chlorine. Deepening or appearance of color after some time is due to combined chlorine.

Orthotolidine-arsenite test:⁶ This is a refinement of the orthotolidine test. It determines separately the free and combined chlorine in water.

Starch iodide test: It is carried out to detect residual or free chlorine in tap water. Add 1 ml of freshly prepared starch solution to 5 ml of water to be tested. Add a crystal of potassium iodide. If free chlorine is present in water, blue color appears immediately. Cadmium iodide is used for the same purpose in Horrock's test.

Purification on Medium Scale

This is needed when water is obtained from wells, springs and tanks. Disinfection is done by chlorination, usually by adding bleaching powder or chlorinated lime ($\text{CaO} + \text{CaOCl}_2$). It is a cheap, reliable, easy to use and safe disinfecting agent. It is a white, lumpy or amorphous powder, with feeble chlorine smell and bitter saline taste. Chlorine content in fresh bleaching powder is 33 to 38 percent but deteriorates on standing to 25 or 20 percent. Bleaching powder is rendered relatively stable if it is mixed with quick lime or calcium oxide. The usual ratio is 4:1. This mixture is known as stabilized bleach and does not allow chlorine content to fall below 33 percent. Storage should be done in a cool, dark, dry place in a tight container.

To disinfect a well or tank, find the quantity of water as described earlier. Then add bleaching powder at the rate of 2.5 gm to 1000 liters of water. This gives about 0.7 mg of applied chlorine per liter.¹⁵ The dose may be increased by 1.5 to 2 times in epidemics and by 4 times to kill cyclops or viruses. If one is not sure about the quality of bleaching powder (i.e. chlorine available) or the chemical and organic content of water (i.e. chlorine demand) it is better to do disinfection after performing Horrock's test which indicates the chlorine demand of water, i.e. the amount of a particular bleaching powder needed for disinfecting a particular water source to get 1 PPM of chlorine.

The procedure recommended by the Ministry of Health for chlorination of wells is addition of approximately 10 gm bleaching powder per 1000 liter of water assuming its chlorine content to be 21 percent.¹⁶ The quantity to be added would be proportionately reduced if the powder is stronger. This quantity is sufficient to give a chlorine level of 2 ppm immediately after chlorination and 0.5 ppm after half an hour.

The required quantity of bleaching powder is placed in an enamelled bucket (the galvanized bucket gets corroded). Not more than 100 gm should be kept in a bucket at a time. The powder is made into a thin paste by adding a little water. Then more water is added to make the bucket three fourth full. After stirring well, it is allowed to rest for 10 minutes for the lime to settle down. The supernatant is transferred to another bucket which is then lowered into the well up to some depth below the surface of water. The bucket is then jerkily moved up and down and around so as to effect good mixing.

At least half an hour should be allowed before water is drawn from the well after adding bleaching powder. It is best to do chlorination at night. It is advisable to ensure that the water has a minimum free residual chlorine level of 0.5 mg per liter an hour after adding bleaching powder. If not, more bleaching powder should be added.

When it is desired to ensure constant chlorination of water, the single or double pot method may be used. In these methods 1 kg bleaching powder mixed with 2 kg coarse sand is kept in a specially designed pot with appropriate holes. This pot is kept immersed in the well. It is sufficient to provide chlorination to the well for 2 to 3 weeks at a time.¹⁷

The method recommended by the Ministry of Health and Family Welfare for this purpose is as follows:¹⁶

- Take an earthen pot
- Make seven holes in its bottom, each of 6 mm diameter
- Place at the bottom a layer of pebbles
- Place over this a layer of gravel
- Fill in a mixture of 1.5 kg bleaching powder, 75 gm sodium hexametaphosphate and 3 kg coarse sand
- Fill up with another layer of gravel
- Suspend the pot, without closing its mouth, in the well in such a way that it is about one meter below the surface of water
- This arrangement is sufficient for a week for a well with 9,000 to 13,000 liter water used by 20 to 30 persons.

Purification of Tube Well

One match box of bleaching powder is dissolved in one liter of water. After stirring well, it is kept for some time to settle down. Then the supernatant is divided into two parts containing 500 ml each. One part is used to wash the inner parts of tube well and rest 500 ml is poured into the pipe and then it is covered with clothes and kept for overnight. From next morning water can be used after initial wash out.

Purification of Pond

One kg of bleaching powder is mixed with nine kg of lime. Then it is distributed in 5 to 6 pouches. These pouches are kept scattered over the pond by a stick in such a way that it will touch the water level but should not be immersed totally under the water.

HORROCK'S TEST

The apparatus consists of one black and 6 white cups (each of 200 ml), a 2 gm spoon, a stirring rod, a special pipette and cadmium iodide starch solution—all put in a box. Fill the black cup with water to be tested. Add one spoon of bleaching powder and stir with a rod. Fill the remaining 6 white cups with water up to the mark indicated. Add with the help of the pipette one drop from the black cup to the first cup, 2 drops to the second and so on up to 6 drops to the last cup. Wait for half an hour. Add a drop or two of cadmium iodide starch solution to each white cup and note which cup shows

bluish color first. The number of the drops added in this cup gives the number of spoons (1 spoon = 2 gm) of bleaching powder required for 450 liters of water (100 gallons) to provide 1 PPM of chlorine.

Other examples of medium scale disinfection are the use of ozone and ultraviolet rays for disinfection of swimming pools.

Purification on Small Scale (Domestic Level)

This can be done by the following methods.

BOILING

This is a simple and effective method. Boiling for 5 to 10 minutes kills most organisms. It also removes temporary hardness. Boiled water is insipid in taste. The taste can be regained by shaking it vigorously for some time, so that the gases get dissolved in it.

DISTILLATION

It is very costly but safe. In Kuwait, sea water is distilled on a large scale because oil is available cheap for use as fuel.

CHEMICALS

Bleaching powder: It can be kept as a strong solution, small quantities out of which can be used for adding to one or 5 liters of water. 200 gm bleaching powder (available chlorine 25%) is required to be added to one liter of water to make a 5 percent chlorine solution. One drop of this solution contains approximately 2.5 mg chlorine, which is sufficient to disinfect one liter water.

Chlorine tablets: These can be used for rapid chlorination while on tour, in camps or in the household. There are several types. One Halazone tablet is needed for one liter water. One chlorine tablet formulated by the National Environmental Engineering Research Institute, Nagpur, is needed for 20 liter water. One tablet of Aquapura containing 40 mg p-carboxybenzenes ulphon-dichloroamide, is sufficient for 10 liter water.

Iodine: This can be used for emergency purposes. Two drops of 2 percent solution of iodine in alcohol are sufficient to disinfect 1 liter water. Even tincture iodine can be used if necessary (1 drop in a liter water).

Potassium permanganate: It may be used by adding an amount just sufficient to give pink color. However, this is an expensive and unreliable method. It may be effective against *Vibrio cholerae*, but not against other organisms.

Alum: It should be used for all turbid waters, adding 0.1 to 0.4 gm per 5 liters of water. This should be a step before chlorination if the water is turbid. Adding alum also results in some decrease in bacterial content

of supernatant water after the flocculum has settled down.

FILTRATION

Domestic methods in use are:

Four ghara method: In this method, well known since olden days, three earthen pitchers or gharas containing muddy water, sand and charcoal respectively, are placed above an empty pitcher which receives filtered water. Water becomes clean and its bacterial content is reduced to some extent, but chemical disinfection is necessary to ensure safety from pathogenic bacteria.

Ceramic filters: These are special microfilters in which water is made to pass through the micropores of a “Candle” placed inside the water container. Bacteria are unable to pass out through these micropores, but viruses may still be present. These filters are of various types—*Pasteur-Chamberland type* (candle made of diatomaceous infusorial earth called kieselgurh) or *Katadyn type* (in which the filter is coated with a silver catalyst which kills bacteria by oligodynamic action of silver ions). The candle in the ceramic filter gets clogged with bacteria after constant use, hence it should be scrubbed with a hard brush every 3 days and boiled at least once a week. These filters are suitable for use in homes and offices.

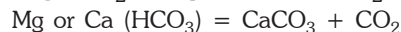
Special Treatments in Water Purification

Sometimes additional techniques may be needed for water purification beside those described above. These are briefly described below:

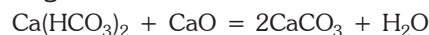
- **Active charcoal**—This may be used to remove bad color and odor. The bacterial content is also reduced partially.
- **Copper sulfate**—This may be used in a dose of 0.1 to 1 PPM to check the growth of algae. It is placed in gunny bags that float in sedimentation tanks.

- **Removal of hardness**—Temporary hardness is removed by boiling, by adding lime or by adding washing soda. The concerned chemical reactions are as follows:

Boiling: CO_2 escapes and CaCO_2 settles down:

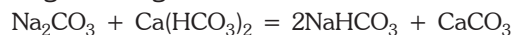


Adding lime:

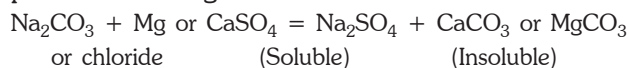


CaCO_3 settles down.

Adding washing soda or soda ash:



Washing soda also removes permanent hardness as per the following reaction:



Sometimes lime-soda ($\text{CaO} + \text{Na}_2\text{CO}_3$) is added to remove both types of hardness.

On a large scale both types of hardness are removed by the base exchange or permitted method. Permutit or sodium permutit is a complex compound with the formula $\text{Na}_2\text{Al}_2\text{Si}_2\text{O H}_2\text{O}$. The cation sodium gets exchanged with calcium and magnesium present in hard water. Once the activity of sodium permutit is exhausted, it can be regenerated by treating it with strong brine (sodium chloride solution).

- **Desalination**—Membrane technology has been successfully used to obtain potable water from brackish water commercially.
- **Removal of fluorides, iron and arsenic** Practical technology for defluoridation plants, iron removal plants and arsenic removal plants suitable for Indian conditions is now available.¹⁸

In the preceding section, various procedures involved in purification of water have been described. It would be of interest to know which procedure helps in removal of which impurities. Such information is given in **Table 6.2**.

TABLE 6.2: Effectiveness of different water treatment procedures

	<i>Aeration</i>	<i>Chemical coagulation and flocculation</i>	<i>Sedimentation</i>	<i>Rapid filtration</i>	<i>Slow sand filtration</i>	<i>Chlorination</i>
Augmenting dissolved O_2 content	+	0	0	—	—	+
CO_2 removal	—	0	0	+	++	+
Turbidity reduction	0	+++	+	+++	++++	0
Color reduction	0	++	+	+	++	++
Taste and odor removal	++	+	+	++	++	+
Bacteria removal	0	+	++	++	++++	++++
Fe and Mn removal	++	+	+	++++	++++	0
Organic content removal	+	+	+	+++	++++	+++
+ to ++++	Increasing positive effect					
0	No effect					
—	Negative effect					

Note: Majority of the treatment procedures are capable of reducing virus content. Efficacy may vary depending upon design, operation, water quality and temperature. Prechlorination treatments like slow and or biological filtration, flocculation with rapid filtration and lime flocculation are highly effective and may reduce viruses by 90%. Storage and rapid filtration may also remove viruses up to certain extent. However, all these alone are not adequate and disinfection is the most effective treatment for removal of viruses.

Swimming Pool Hygiene

The pool may be a covered one or an open air one. It has a sloping floor, the depth gradually increasing from 1 to 2 or 3 meters.

Both surround: It is 1.4 m wide, sloping outwards and drained by a gutter all around. On the inner side of tank, on all 4 sides, there is a gutter just above the water level for spitting. It drains out separately.

Facilities: These include drinking water, lavatories and bathrooms with shower.

Foot bath: Before entry into tank, bathers should dip their feet in a small tank of water containing $\text{Na}_2\text{S}_2\text{O}_3$, NaClO or bleaching powder.

Types of water pollutants

- *Particulate matter* including mucus, saliva, sputum, dead epithelial cells from bathers, sand, mud, dropping of birds, etc.
- *Bacteria*
- *Soluble matter.*

The water of the swimming pool can be purified by a continuous method or by a fill and empty system. The *continuous method*, though costly, is more desirable. In this, water from the tank passes continuously through a small purification plant (rapid sand filter type) by the side of the tank where coagulation, filtration and chlorination take place. In the fill and empty method, occasional doses of disinfecting solution are applied. The pool is emptied once in 14 days to scrub the walls and floors. It is not an ideal method.

Water Problem in India

There is widespread scarcity of water in India for agriculture as well as domestic use. The problem is much more acute in rural areas. The first major national effort in this direction was made in the form of National Water Supply and Sanitation Program launched in 1954. In 1972-73 an Accelerated Rural Water Supply Program (ARWSP) was launched with 10% assistance from the Center to provide drinking water to problem villages. The Minimum Need program launched during the fifth plan also focussed at provision of drinking water. The water supply Program got a boost in 1986 with the setting up of a *National Drinking Water Mission* with the target of covering all problem villages by the end of 1992-93. The Mission has several *submissions* under it, aimed at specific areas such as guinea worm eradication, control of fluorosis, excess iron removal, control of brackishness, conservation of water, scientific location of water resources and recharge of groundwater qualifiers. There are also 55 *mini-missions* under the National Mission. A mini-mission is essentially a district based concept for sustainable water supply on long-term basis with close involvement of the community and the NGOs.

India organized in 1990, in collaboration with UNDP, a “Global Conference on Safe Water for 2000 AD.” The New Delhi declaration adopted at this conference was adopted by the UN General Assembly in Nov 1990. The *four guiding principles* of this declaration, adopted as strategy for the 1990’s, are as follows:

1. Protection of environment and safeguarding of health through integrated management of water resources besides liquid and solid wastes.
2. Institutional reforms, including changes in procedures, attitudes and behavior, to promote an integrated approach and the full participation of women at all levels.
3. Community management of services backed by measures to strengthen local institutions in implementing and sustaining water and sanitation Programs.
4. Sound financial practices to be achieved through better management of existing assets and widespread use of appropriate technologies.

The operative norms for rural water supply are as follows:

- Water source to be available within 1.6 km in plain and within 100 meters in hill areas.
- One hand-pump or standpost for every 250 persons.
- Desert districts to supply 40 liters per capita drinking water per day for humans in addition to 30 liters for cattle.
- Water to be free from biological and chemical contamination.
- Preference to be given to scheduled caste and scheduled tribe localities.

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Residential environment of man, as defined by the WHO,¹ includes the physical structure that man uses and the environs of that structure, such as the necessary services, facilities, equipments and devices, etc. Soil is an essential part of housing not only because it provides the base for the residential building but also because open earth is very much a part of housing—either as lawns within the pacca houses in cities or as the open ground or courtyard in the kaccha houses in villages. In addition, soil also forms part of occupational environment in case of farmers, laborers and potters, etc. Hence, it is appropriate to consider first of all the implications of soil as part of man's physical environment.

Types of Soil

The superficial layer of soil is called supersoil and is made of decaying animal and vegetable matter (humus) mixed with sand, dust and stone particles. The soil below the surface is called subsoil which may be:

- Rocky or stony, made up of chalk, limestone, sandstone, gravel, slate, etc.
- Clayey or black soil made of clay which does not soak moisture and is damp and cold.
- Sandy, which is dry and healthy but not stable.
- Loamy, made up of clay and sand.
- Filled or made soil: Soil made up by filling low lying places with refuse and debris. It is not suitable for making a house for 10 to 15 years as it sinks and sometimes stinks.

Soil and Health

Soil as an environment may affect health and transmit disease if it is polluted with causative agents which may be physical, chemical or biological.

Physical Agents

Rocky and sandy soil make the climate hot while clayey soils make it damp and cold. Made soil may emit offensive odors. Soil may have radioactive deposits, as in Kerala, or may be polluted with radioactive fall-outs. High level of groundwater makes the soil damp.

Chemical Agents

Pesticides, insecticides, herbicides and fungicides used in agriculture may pollute the soil. They may reach man through water and vegetables. Common ones are DDT, aldrin and dieldrin. DDT has been detected in breastmilk of women in many parts of the world, its origin being traced to DDT sprayed in the fields from where it reaches man through foodstuffs.

Biological Agents

All sort of life subsists on or in the soil and it may be regarded as a living community of fungi, bacteria, protozoa and metazoa. Some are harmful and pathogenic while others are harmless and even useful. Soil bacteria dispose of all the organic waste matter dumped on the soil, if the required warmth, oxygen and moisture are available. They break up complex nitrogenous matter, such as proteins, into ammonia, H₂S and simple nitrogenous compounds and finally convert them by oxidation into end products such as nitrites, nitrates, carbonates, chlorides and sulphates. The nitrogenous products are utilized by plants to form plant proteins. Plants proteins, when eaten by animals, are converted to animal proteins. Plant and animal proteins are decomposed again by soil bacteria, thus completing the *nitrogen cycle*. Bacterial decomposition of organic matter is minimum in rocky soil and maximum in loamy soil. It may occur slowly in clayey and moist soils, which contain too much moisture. This may account for the stinking smell from such soils. Most of the bacteria in earth are in surface soil, their number and activity decreasing with depth. There are very few bacteria between 1.2 and 1.8 meters; beyond 3 meters there is no bacterial activity.

Harmful and pathogenic bacteria that transmit diseases survive in soil with difficulty. Most of them die in their struggle with the more hardy saprophytes. Others survive if the soil is favorable and contains air, moisture and organic matter. The following *pathogenic organisms* may be found in soil:

- Spores of *Cl. tetani* and *Cl. welchii*, for which soil is a natural habitat. Any wound polluted with such soil is liable to develop the grave consequences of these infections.

- Spores of *B. anthracis*: However, direct infection through soil is rare.
- Tubercle bacilli, *C. diphtheriae* and streptococci can survive in dust, especially in shade. When inhaled, they can cause disease.
- Organisms causing gastrointestinal infections. Examples are:
 - *V. cholerae*, *S. typhi* and *Shigella*: The typhoid and dysentery bacilli can survive for 30 to 70 days in moist soil and for 20 days in dry soil.
 - Cysts of *E. histolytica* which can survive for six to eight days in moist soil.
 - Ova of helminths: Roundworm ova are very hardy and can survive long in soil, upto years. Hookworm larvae can survive for two months in damp soil.
 - Viruses of infective hepatitis and polio can survive in moist soil.
 - Leptospirae passed by rats in urine. They may infect the soil, particularly in mines.

They can enter the human skin directly.

Finally, it may be mentioned that polluted soil results in four major health problems. These are roundworm infection, hookworm infection, tetanus and gastrointestinal infections caused by drinking water from shallow wells polluted by seepage of subsoil water from polluted soils.

Housing

Housing, as an environment, means the building or structure in which we live, work, rest and play. They may be private building, residential houses or public building (club, school, theatre, workshop, factory, etc.). They should be so constructed and laid out as to promote physical, mental and social well-being.²⁻⁴

For physical well-being the house must provide enough space inside and outside to promote health by good light and ventilation and to prevent respiratory and contact infections. It must be constructed on firm and dry soil with subsoil water at a depth more than 3 meters.

For mental well-being the house should afford enough privacy and safety against thefts. It should be situated at a place away from excessive noise and offensive odors.

For social well-being, the size and construction of the house and the amenities provided should be compatible with human dignity and social respectability; and the neighborhood should be congenial.

Rural Housing

Village and small towns often come up and grow without an organized plan. Light and air are freely available in rural India and there is no dearth of space. Yet, people live in dark, ill ventilated, damp and

overcrowded houses built back to back. Very often there is only one room used for cooking, sleeping, storing of grain and even tethering of cattle. Most houses are without bathroom or latrine. Houses are made of mud, kaccha bricks or split bamboo and are plastered with dung or mud. Roofs are thatched or have tiles. There is no provision for smoke outlet. Waste water stagnates inside and outside most houses. Flies breed on cowdung and mosquitoes breed in puddles of waste water. Overcrowding and poor housing hygiene are responsible for lot of ill health in villages. Poor housing in villages is due to multiple causes. These include ignorance, poverty, traditions, fear of theft and dacoity, apathy and indifference.

A model village house should have the following characteristics:

LAYOUT

The huts or houses should be built in parallel lines, with a free passage of at least 9 meters between two huts. The roads should be parallel and crossing at right angle.

SITE

The house should be constructed on loamy soil with subsoil water below 3 meters or more. The house should face the sun and have access to open air. Green vegetation around the house in the form of vegetable, flowers and trees makes the environment pleasant and healthier.

BUILDING PLAN

It should have at least two rooms with a separate kitchen and verandah. The built up area should not exceed one third of total area. There should be two windows, opposite each other, at least 1 m × 0.5 m in size, their area being at least one-tenth of the floor area. Plinth should be 0.3 m in height. Each room should be 3 m × 3.5 m × 3 m in size with impervious floor and white washed walls. There should be two ventilators, 0.3 sq m each, near the ceiling. The kitchen should have a smokeless chullah and a chimney for smoke outlet.

CATTLE SHED

It should be at least 8 to 10 meters away from the living house and should be open on all sides. A provision of 3 square meter per head of cattle is adequate.

Urban Housing

Old towns and cities have developed without proper planning. Haphazard growth ignores the need for wide and straight streets, roads and open places. Back-to-back houses are constructed without proper ventilation. Public places such as playgrounds, parks, gardens,

schools, libraries, markets, swimming pools and entertainment theaters, etc. are absent or scarce in such areas. The problem is made worse by ever growing population of the towns due to high birth rate and immigration from rural areas.

The problems of urban housing are increasing with rapid increase in urban population. One-fourth of world population was living in cities and towns in 1959. By 2025, this proportion is expected to reach 60 percent. Health of residents is affected by multiple aspects of housing, such as per capita floor area, illumination, vectors and reservoirs of disease, etc.⁵

The Environmental Hygiene Committee appointed by the Government of India in 1949 has recommended the following standards for housing in general.⁶

- *The site* should be on a street of adequate width in pleasing surroundings free from hazards of flooding, landslides, fly breeding, mosquito breeding and from the nuisance of dust, smoke, foul smell and excessive noise. The soil should be dry.
- *The set back* should be such as to permit enough light and ventilation. *Built up area* should not be more than one third in thinly populated and more than two-thirds in thickly populated areas.
- *The floor* should be pucca, rat-proof and smooth. The height of plinth should be as per approved standards and proper damp proofing should be done.
- *The walls* should have minimum thickness of 30 cm and should be plastered on both sides. They should be damp proof.
- *Roof height* should be not less than 3 m unless the room is airconditioned.
- *The number of rooms* should be at least two or more as per the size of family.
- *The floor area per capita* should not be less than 4.5 sqm (50 sq ft), the optimum being 9 sqm. Minimum floor area of a room should be 9 sqm if occupied by one person and 11 sqm if occupied by more than one person. Cubic space should be at least 14 cum (500 cu ft) per capita; preferably it should be double this figure.
- *At least two windows* should open directly into the compound, street or open space. They should be placed not higher than 1 m from the floor. Windows and doors should ensure privacy. The window shutters should be able to cut off heat, glare and wind when required.
- *Lighting* should be adequate during both day and night.
- *The kitchen* should have enough light and ventilation. It should be protected against dust and smoke and should have adequate arrangements for storage of provisions, food and fuel. It should have good water supply and drainage including a sink for washing utensils.

- *Water supply* of the house should be adequate along with suitable bathing and washing facilities.
- *Sanitary latrine* of approved type should be provided.
- *An open courtyard* or terrace should be provided for comfortable sleep during night in areas where summer temperature rises above 40°C.
- *Ample space* and other arrangement should be provided for domestic occupations such as dairying, poultry, smithy (blacksmith, goldsmith, etc.), carpentry or other cottage industries.
- *Construction materials* should conform to the approved standards of plumbing, structural strength, fire protection and electric installations.

Harmful Effects of Improper Housing

Overcrowded, ill ventilated and unhygienic housing is associated with increased respiratory infections. In addition, scabies and louse infestation are more common in such situations. Poor living conditions also have indirect effects on mental and social health, resulting in more school drop outs, delinquency, drug abuse, crimes and other antisocial acts. The problem is further aggravated by absence of privacy and recreational facilities and by lack of safe water supply and sanitary facilities.

It may be mentioned that general morbidity and mortality are related to overcrowding, which is best expressed as the average number of persons per room in a household. *The accepted standards for residential accommodation are as follows:*

- Number of rooms should be adequate to provide for not more than two persons per room. For this purpose, infants below 12 months are not counted while children 1 to 10 years old are counted as half unit.
- Persons above nine years of age belonging to opposite sexes should not have to share a bedroom, unless they are couples living together.

Recent Trends in Housing

Industrialization, overpopulation and urbanization have led to construction of compact, concrete buildings in most cities, without much regard to natural ventilation and cooling. Moreover, the energy costs of cooling have become prohibitive. The following newer trends are being tried to improve the living environment of buildings.

Cleaning of Air

Lack of ventilation may be found in poor slum dwellings as well as in modern multistoreyed offices and apartments. Air in tightly sealed offices and houses may be 100 times more polluted than outdoor air.⁷ A considerable amount of domestic pollutants can be

contributed by smoke (from fuel or cigarettes) and synthetic chemicals. The latter are commonly used in furniture, carpet backing, building materials and office supplies. Research has shown that indoor plants can offer protection against such toxic substances. For example: spider plants and golden paths are especially effective against formaldehyde emanating from plywood, particle board, carpeting, foam insulation and some cleaning agents. Similarly *Gerebera* daisies and *Chrysanthemums* eradicate benzene, a carcinogen in paints and varnishes, tobacco smoke, some plastics, inks and detergents. *Marginata* and *Peace* lilies target trichloroethylene, which is found in paints, varnishes and drycleaning solvents. Placing at least one plant for every 100 square feet of indoor space is recommended by researchers.⁷

Lowering of Temperature

Air conditioning is not possible for most dwellings because of high financial and energy costs. Much can be achieved in this direction by proper construction of houses. The following points are important in this connection.⁸

- Location of rooms should be such that they are situated along the northern and eastern walls of a building. These are the cooler walls. Cupboard and buffers (toilets, storeroom) can be located along the southern and western walls.
- The building need not be open on all four sides. This ensures that all four walls are not exposed to sunshine.
- Walls should be hollow with one and a half inch space between two brick layers. This provides excellent air insulation.
- Sixty percent heat in a building enters from the roof which is exposed to sun throughout the day. Roof heat can be prevented by:

- Using mechanized bricks for roofing. These bricks have holes, thus providing insulation.
- Using the ancient Rajasthan practice of embedding a layer of inverted earthen pots in the roof while constructing it. This provides excellent air insulation.
- Using a roof-top water cooling system based on water sprinkling and evaporation, using mechanized devices controlled by electronic sensors.

The above techniques increase construction costs by only about five to ten percent but result in lowering of temperature of the building by about 10-15°C. As a result it is possible to achieve 30 to 40 percent reduction in the energy cost for cooling of building.⁸

Rajiv Gandhi Gramin LPG Vitarak Yojana⁹

- A scheme to reach LPG to every rural household.
- Low cost convenient cooking fuel for rural women.
- New employment opportunities for rural youth.
- Will stop unnecessary cutting of trees and encourage afforestation.

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Physical Environment: Wastes and their Disposal

Wastes constitute an important part of the environment to which man is continuously exposed. Wastes are of three types.

REFUSE OR SOLID WASTE

This includes all unwanted or discarded waste material arising from houses and streets and from commercial, industrial and agricultural activities of man.¹ In other words, the term 'refuse' is applied to all solid waste from human habitations that is not carried by the sewers, i.e. all waste other than sullage and nightsoil. It includes *public refuse* (originating from homes, hotels, institutions, streets, stables and markets) and industrial refuse. The refuse originating from homes or *domestic refuse* consists of garbage, rubbish and ash. *Garbage* is the waste from food during its handling at various stages including preparation, cooking and serving. *Rubbish* comprises dirt, dust and bits of paper, wood, clothing, glass, rubber, plastic, metal, etc. *Ash* is the residue after burning of fuel. The term *litter* is sometimes used in place of refuse for solid waste in rural areas.

EXCRETA OR NIGHTSOIL

It implies feces as such. The sullage water containing nightsoil is called sewage.

SULLAGE

It is also called waste water or slop water and comprises all liquid wastes including industrial waste but excludes *nightsoil*.

Wastes and Health

Different types of wastes impinge upon physical, mental and social health in various ways, as described below:

- There are many harmful agents in the wastes. The most important are biological agents which pollute water and food and cause alimentary infections like cholera, typhoid, dysentery, infective hepatitis, polio, ascariasis and hookworm disease, etc.
- Wastes breed vermin and pests. Examples are:

- Mosquitoes that transmit insect-borne diseases like malaria and filaria
- Common house flies which transmit infections mechanically
- Many other insects and worms that cause nuisance, e.g. cockroaches, crickets and ants
- Rats, thriving on refuse.
- Sullage water, refuse and nightsoil, all create intolerable nuisance of sight and smell.
- Dust may harbor tubercle bacilli and other germs which cause diseases if inhaled.
- Soil polluted with nightsoil may be rich in tetanus spores.

Recycling of Wastes

Wastes, despite their name, are not so. The so called wastes contain plenty of useful substances which can be reused with advantage. Let us have a look at different types of wastes.

Refuse or Solid Waste

Solid waste essentially consists of two components, non-organic and organic. Nonorganic component comprises paper, plastic, rubber, metal, glass, etc. These can be sorted out, collected and recycled in a commercially viable manner. Organic waste may be of plant or animal origin. It can be composted in landfills. If done properly using modern technology, this can yield useful byproducts like manure and combustible gas, mainly methane.

Continuous dumping of unsorted solid waste leads to formation of diverse chemicals which react with each other, releasing a substance called leachate, which is highly toxic, supposedly much more so than arsenic. Over decades of dumping, leachate seeps through subsoil and contaminates groundwater.

Human excreta contain plenty of nutrients which can be recycled for human use rather than lost down the drain. According to a 1992 estimate, annual production of human excreta in Asia was 30 million tons dry weight, containing 9.7 million tons nitrogen, 1.4 million tons phosphorus and 1.9 million tons potassium.^{1a} It is ecologically expedient to recycle these nutrients than to

rely on nonrenewable resources to produce chemical fertilizers.^{1b} It has been suggested that the gap between food production and requirements in India can be considerably reduced by properly treating and recycling nutrients in human excreta.^{1c} An example in this direction has been set by China where 90 percent nightsoil is used in agriculture.^{1d} Aquaculture is another area where human excreta can be used. In India, this is practised in West Bengal, where there are more than 130 sewage fed fisheries covering about 12000 hectares.^{1a}

Sullage

Water contained in sullage (as well as sewage) is a precious commodity which must be retrieved, saved and reused. It is being increasingly realized now that fresh water supply in the world is limited and all water must be suitably recycled after use.

There are four stages in dealing with wastes:

1. Reception
2. Collection
3. Transportation to disposal point
4. Disposal.

The problem of disposal of wastes differs in rural and urban communities. In villages the problem is largely tackled on an individual basis. There are no laws or bylaws. Methods followed are based on tradition, simplicity and economy. In urban areas the sanitation measures adopted are community based, such as underground sewage. Sanitary methods are enforced by laws, bylaws and rules made by the municipality.

The disposal of wastes will be described in this chapter under four headings—Refuse disposal, Excreta disposal, Sewerage disposal and Sullage disposal.

Refuse Disposal

Proper disposal of refuse is essential for maintenance of environmental sanitation. The methods of refuse disposal depend upon the quantity of daily refuse production in a community. An earlier survey² had estimated per capita daily solid waste output to be 0.5 kg in Kolkata and 0.3 kg in Pune and Nagpur. The daily municipal collection in Delhi is 8000 metric tonnes, indicating an average daily output of 1 kg per capita.³

OPEN DUMPING

Dumping solid waste on vacant land is not a desirable practice. It is unhygienic. It breeds flies and other insects, attracts rats, dogs, etc. and even entails the danger of dry refuse catching fire.

SANITARY FILLING OR CONTROLLED TIPPING

This is a satisfactory method in which the refuse is placed in a designated area and covered with a layer

of earth. When level ground is used, sanitary filling is done in trenches 2-3 m deep and 3-10 m wide. When naturally occurring depressions, excavations and pits are to be filled up this can be done by tipping the refuse into them in the form of alternate layers of refuse and earth. A 30 cm layer of earth is adequate between two layers of refuse. Sanitary filling of low lying places is a useful method of reclaiming such land for buildings, playgrounds, gardens and agricultural farms. The process of sanitary filling is much facilitated by the use of bulldozers. There are about 50 sanitary landfills in Delhi at present.

Physical, chemical and bacteriological changes occurring within the buried mass of refuse render it innocuous within 4-6 months after the decomposition of organic matter is complete. During the decomposition process the temperature rises to 60°C within a week, killing various pathogens. It takes another 2-3 weeks for the temperature to cool down. Organic gases are liberated during the process of decomposition. These can be gainfully utilized if appropriate technology is used. Municipalities incur heavy expenditure on collection and disposal of solid wastes. It has been estimated that such expenditure may account for as much as one fifth of the total municipal budget in some industrialized countries.⁴

BURNING

Burning of refuse, though common, is not a desirable practice. It leads to production of harmful gases and chemicals, some of which may even be carcinogenic. Hospital waste, because of being infected, needs to be burnt in an incinerator. The process involves:

- Drying
- Heating to ignition
- Airing to supply oxygen
- Supply of auxiliary fuel if the refuse is moist.

There is little air pollution if temperature is high, around 830°C.

COMPOSTING

The dictionary meaning of compost is “A mixture of various decaying organic substances, as dead leaves, manure, etc. for fertilizing land”. Composting at small scale is a common method of disposal of refuse, either alone or in combination with or without human or animal excreta. The resulting product, called compost, is a good organic manure for agricultural purposes.

Composting with Animal Dung

It has been a common practice in the villages to mix animal dung with other organic matter such as straw and leaves, etc. and to leave it in manure pits for fermentation for 4-6 months, at the end of which manure is ready for application to fields. Nowadays animal dung is mixed

with refuse in alternate layers in compost pits. When the pit becomes full it is covered with earth and left for ripening. If the refuse is too dry, water or sullage water is added to expedite fermentation. Pits are lined with stones or bricks with open joints. Properly done, composting is quite hygienic and paying.

Composting with Nightsoil

In Indian context, composting of town wastes invariably means admixture of refuse and nightsoil.^{4a} Because of the health hazards involved in handling human excreta, this method has not found much favor. It is suitable for communities with population between 5000-100,000. It has to be carried out with proper precautions so that there is no fly breeding in the compost heap. In practice, fly production is difficult to control.

There are two methods of composting—aerobic and anaerobic. The aerobic method in India was standardized by Sir Albert Howard in early 30's at Indore. Hence it is also known as Indore method.

The method recommended in India is the *Bangalore method* based upon anaerobic composting. This method was developed at the Indian Institute of Science, Bengaluru, in collaboration with the Indian Council of Agricultural Research.⁵ Layers of refuse and nightsoil are alternated (15-25 cm of refuse and 5 cm nightsoil) till they rise 30 cm above the ground level. The top layer of refuse is covered with excavated earth in such a manner that it is solid enough to allow a person to walk over it. The temperature in the pit rises above 60°C, destroying all pathogens. It takes 4-6 months for completion of composting.

In Indore (Aerobic) method, the compost mass is completely turned on 4-7th day, so that the material on outside is turned in. This is repeated 5-10 days after the first turning. After 2-3 weeks more, the compost mass gets converted into humus.

Some countries like Israel, Switzerland, Germany and Holland use mechanical composting, which uses the aerobic technique.

Here all reusable material is first salvaged from the refuse. The remnant is then pulverized (particle size less than 5 cm) and mixed with sewage or nightsoil. The mixture is indubated, controlling factors like temperature, aeration, pH, moisture and carbon-nitrogen ratio. Compositing takes place within 4-6 weeks. It has been recommended that mechanical compositing should be introduced in cities in India where the population is more than 5 lakhs.⁶

Excreta Disposal

Fecally transmitted diseases constitute an important segment of preventable morbidity and mortality. ICMR estimated almost three decades ago that these accounted for 50 million deaths every year.⁷ The current

picture is no better. Food may be contaminated with feces through fingers, flies, water or soil. The aim of safe excreta disposal is to provide a *sanitation barrier* between feces and man.

Two types of methods are in vogue for disposal of nightsoil—the nonsewage and the sewage method. The nonsewage methods include the conservancy method and sanitary latrines. The former involves manual handling of human excreta, which is collected and carried for disposal at some other site. The latter does not involve human handling of excreta, which is disposed of on the spot. The sewage method involves water carriage of excreta through a system of drains and sewers for disposal at a sewage treatment plant. The sewage system, though very hygienic, is very costly. Studies undertaken by the World Bank during the International Water Supply and Sanitation Decade (1981-1990) led it to conclude that, “In industrialized countries, users and responsible officials have come to view the flush toilet as the absolutely essential part of an adequate solution to the problem of excreta disposal. This technology, however, was designed for maximal user convenience rather than for health benefits. The problem facing developing countries is a familiar one; high expectations coupled with limited resources. There is no foreseeable way that waterborne waste disposal, with an average investment cost of around \$300 per person, can be made affordable in countries in which annual per capita income averages less than that amount. In addition, implicit in the decision to provide sewerage is a decision to provide a water connection to each house. About 40 percent of the water from this connection will be used for no essential purpose but to flush away wastes. Clearly, lower cost solutions have to be found for the majority of people. Planners, feel, they have to press for sewerage because, without it, public health will not be secure. Yet, sewer systems in developing countries are not well maintained. Sewage treatment works commonly discharge effluents in a condition little better (and in some cases worse) than the incoming sewage. There is, therefore, little realistic basis for the commonly held view that Western sanitation techniques are the appropriate solution for developing countries. Rather, reeducation of engineers to design for maximal health benefits, and to consider the whole range of available technologies, is essential.”⁸

Conservancy Method

Basket type latrines (pail privy), though unhygienic and unsocial, are still used in the country. This method involves manual collection and removal of human excreta to the disposal point. The *nightsoil* from latrines is collected daily by sweepers in buckets and is carried to a nightsoil depot or is emptied into nightsoil carts which carry the excreta to nightsoil depots outside the village or town. The nightsoil is disposed as follows:

- **Trenching:** Nightsoil is filled in trenches and covered with earth. It gets converted into manure in 3-4 months.
- **Composting:** This is done by mixing *nightsoil* with town refuse as already described.
- **Incineration:** Burning of nightsoil with refuse can be done in camps and small communities.
- **Emptying into sewers:** This can be done if there is sewerage system nearby.

Sanitary Latrines

There are many types of latrines in use. The variation are based on economy, simplicity, nature of soil and prevailing customs and habits of people. The qualities of a suitable latrine are:

- It should be acceptable to people
- It should be simple in construction and use
- It should be cheap and materials for construction should be locally available
- It should not involve manual handling of excreta
- It should involve the use of very small amount of water
- It should be hygiene and sanitary and should not lead to environmental pollution.

A global field survey-cum-research project undertaken by the World Bank in 39 communities around the world identified the following five types of sanitary latrines:

1. Pit latrines
2. Aqua privy
3. Septic tank
4. Handflush water seal latrine (PF or Pour Flush Toilet)
5. Composting toilet.

The composting toilet (which involves adding grass or other organic matter to nightsoil in the toilet itself for composting) is not used in India. The *pit latrines* consist of a pit dug into the ground into which the feces drop down and are anaerobically digested. No further treatment is necessary. The *handflush seal latrine* is basically a pit latrine with the provision of a water seal. The *septic tank* is a water tight masonry tank in which anaerobic digestion occurs within the tank and aerobic oxidation of the effluent is achieved through subsoil irrigation. Septic tanks are designed to deal with a large amount of water, which may be sullage water as well as water flushed from cisterns in the usual modern water seal latrines. The *aqua privy* is a small septic tank for family use where there is no water seal near the squatting plate. The inlet pipe through which the faecal matter drops down opens below water level near the bottom of the tank, thus providing the function of water seal.

A brief description of each method is given below.

Pit Latrines

SHALLOW PIT LATRINE

It is about one meter in depth and 0.5 to 1 meter wide with a wooden squatting plate. Nightsoil has to be covered

with loose earth. The pit contents are converted into manure in 2-3 months, which may be used in the fields.⁹ A super-structure is provided for privacy and shelter.

Shallow trench latrines (1-1.5 m deep) and *deep trench latrines* (1.5-2.5 m deep) are similarly used at camping sites.

BORE HOLE LATRINE

It is a narrow pit or hole (30-40 cm diameter) made by an earth auger to a depth of about 6 m. One bore hole can serve a family of 5 for about one year. The pit is closed by filling loose earth when its contents reach within 50 cm of ground level. The fecal matter is converted to harmless manure through the process of anaerobic digestion. It is not in much use today, having been superseded by better methods.

DUG WELL LATRINE

It is an improvement on the bore hole latrine in the sense that no special augur is needed and the larger size permits longer use. A usual pit of 0.75 m diameter and 3-3.5 m depth is sufficient for 4-5 years for a family of five.

In order to avoid the risk of water pollution, the bore hole and dug well latrines should be situated at least 10 meters away from a source of drinking water.

VIP LATRINE (FIG. 8.1)

The pit latrines described above are of the traditional (unventilated) type, with two major disadvantages, namely, bad smell and breeding of flies and other

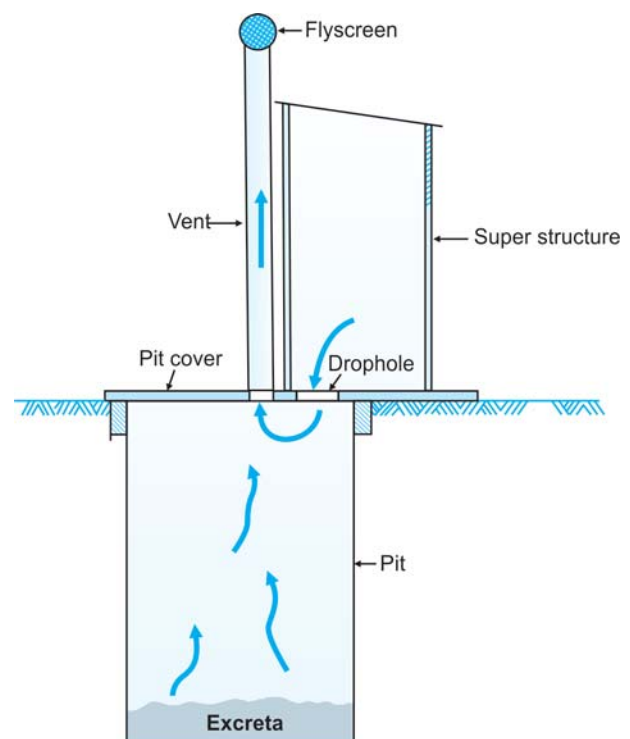


Fig. 8.1: VIP latrine: Basic components (Sectional view)
Source: Worldbank

disease carrying insects. The VIP latrine (Ventilated Improved Pit Latrine) has been designed to remove these disadvantages.¹⁰ It differs from a traditional pit latrine in that it has a tall vertical vent pipe fitted with a flyscreen at the top. This screened vent pipe performs three functions as follows.

1. *Odor elimination*: In a traditional pit latrine, odors enter from the pit into the superstructure. In VIP latrine, odours escape via the vent pipe. This occurs via an air circulatory current whereby air from the superstructure enters the pit, goes upto the vent pipe and escapes into the atmosphere.
2. *Prevention of fly entry*: Flies enter a traditional pit latrine and breed there because they are attracted by fecal odors around the superstructure. Since the superstructure is free of fecal odor in a VIP latrine, flies are no longer attracted towards it.
3. *Prevention of fly escape*: Even if some flies manage to enter the pit and breed there, they cannot escape because the vent pipe is fitted with a screen. It may be pointed out here that the newborn flies emerging from the eggs instinctively fly in the direction of the brightest light, which comes through the vent pipe. This fact explains why the superstructure should be kept reasonably covered and shaded. The effectiveness of the vent pipe in fly control is clear from the fact that in a study comparing two identical pit latrines except for the presence of a vent pipe, 146 flies escaped from the VIP latrine in 78 days compared to 13,953 flies from the unvented latrine.¹¹

The VIP latrine was used on a large scale in Ghana, where a detailed study found that^{11a}:

- It was highly cost effective in comparison to a WC attached to a sewer system.
- It was acceptable to people.
- There was no marked preference for sewer WC over VIP.
- Two features of VIP that appealed to the people were that (a) it does not need water and, (b) it is simple and does not break easily.

HANDFLUSH WATER SEAL LATRINE (POUR FLUSH LATRINE OR PF LATRINE)

This is the latrine of choice recommended for villages and for towns where there is no underground drainage. It is simple, cheap and sanitary and needs at the maximum 1-2 liters of water per user to wash down the excreta from the pan to the pit through the trap. Since the PF latrine does not pose the problem of disposal of effluent, and since it needs only a small quantity of water for its functioning, it is suitable for use in villages and small towns without other facilities.

Construction

A usual design (**Fig. 8.2**) is that developed by the Research cum Action Projects in Environmental

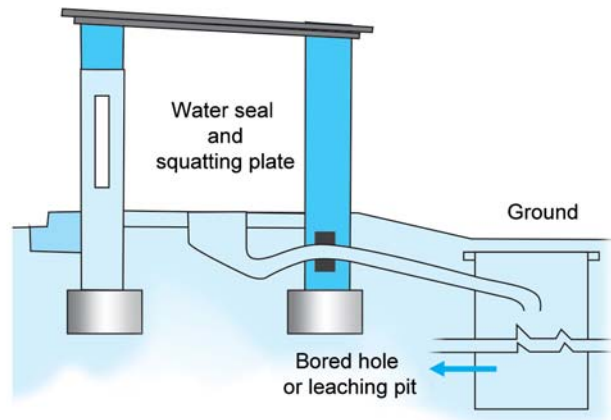


Fig. 8.2: Handflush water seal latrine (RCA type)

Sanitation carried out in the three centers at Poonamalle (Chennai), Singur (Kolkata) and Najafgarh (Delhi).

A lead off pipe about 7.5 cm in diameter and about 1 meter in length with a bend at the lower end extends from the outer end of the trap to the pit. The pit or dug well is 2-3.5 m deep and is round or square with a width of 75 cm. It is better to locate two pits for use alternately behind the squatting plate with a permanent superstructure.

A modification of the above is the PRAI latrine developed at the Planning, Research and Action Institute, Lucknow. In this the pit is directly under the pan and seat. The lower end of the trap is turned in just below the pan to open directly into the pit. There is no lead-off pipe (**Fig. 8.3**). It has the disadvantage that it is difficult to empty or clean unless the superstructure is temporary and movable. However, it is cheaper than the RCA type. Health education for proper use and maintenance of PF latrine is essential.

SEPTIC TANK

The septic tank (**Fig. 8.4**) is so called because of the septic or anaerobic bacterial activity that occurs in it. Fresh sewage contains oxygen which is used up by saprophytic bacteria. The liquid then becomes anaerobic. Further action by microorganisms results in breakdown and digestion of organic matter. Most of the pathogenic bacteria die during this process but amoebic cysts and ova of roundworms can survive in a septic tank, hence the effluent is not free from danger. Proteins, fats and carbohydrates are digested to simpler products like carbon dioxide, ammonia and hydrogen sulfide. Further conversion to stable degradation products like nitrates, sulfates and chlorides has yet to take place. This is achieved by oxidation by aerobic bacteria during the process of subsoil irrigation of the septic tank effluent. The purification of sewage thus occurs in two stages—the anaerobic digestion within the tank and aerobic oxidation outside it.

The chief advantages of septic action are reduction of bulk and smell of the organic matter and destruction

of pathogenic bacteria. Some light solids float in the septic tank and form a layer called scum. The sediment settling down at the bottom is called sludge. It has to be removed at intervals of months or years. The tanks are so designed that cleaning is not required for 3 to 5 years. Annual inspection is, however, necessary. Cleaning is needed when scum is about 7.5 cm thick or when the combined thickness of scum and sludge reaches 50 cm. These should be disposed of in a way that is not hazardous to health. The sludge is removed manually or mechanically.

Construction

It is usually rectangular in shape and is made of impervious walls. The roof comes up above the surface of the ground by about 30 cm. The roof is perforated by

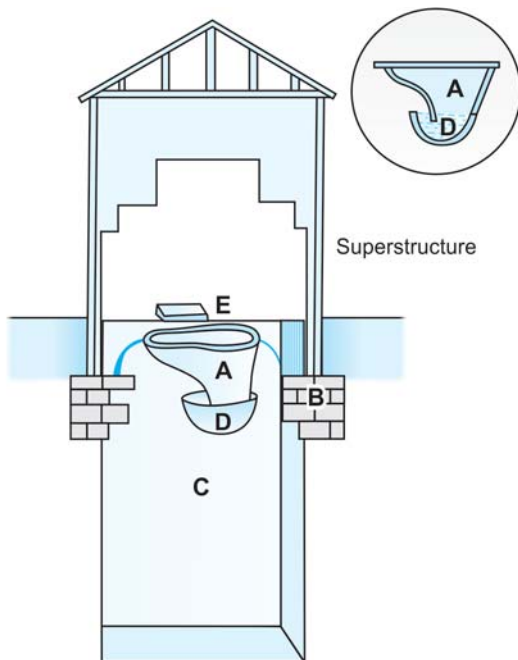


Fig. 8.3: Handflush water seal latrine (PRAI type)

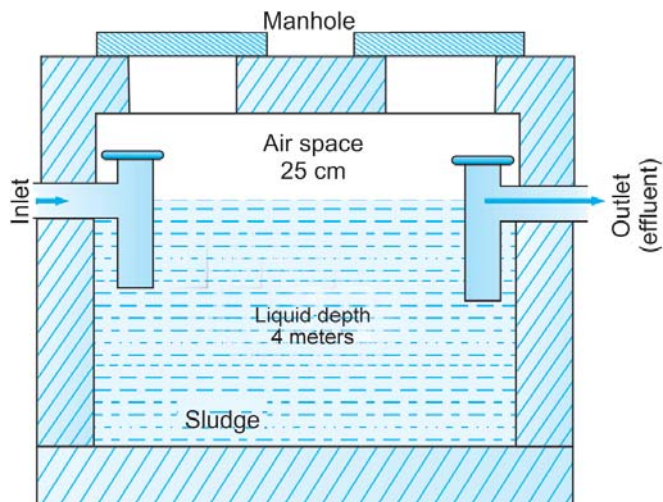


Fig. 8.4: Septic tank

one or more vent pipes for escape of gases and has inspection holes with tight fitting covers. The sullage or soil pipe enters the tank from the side. It is better to have a gully trap for sullage and a P or S trap for sewage before the liquid enters the tanks to prevent escape of gases into rooms or water closets. The sewage is held in the septic tank for 24 hours for sedimentation and digestion. The effluent is let off through an outlet into the soil for subsoil irrigation. This is done by passing the effluent through perforated or open jointed pipes laid down in trenches 0.75-1 meter deep, the trenches being later covered with soil. If ample land is available, the effluent may also be let off as such for surface irrigation. It is preferable to do so after passing the effluent through a biofilter consisting of another tank containing rubble, stones or clinkers for bioaeration so as to make the effluent stable and free from infection and smell.

The size of the septic tank depends upon the number of users. A cubic volume of 75-150 liter per person is adequate for household septic tanks. The length should be twice the breadth. Large septic tanks for a group of houses or for an institution should have length about five times the breadth to permit adequate retention time.

It is worth remembering that the use of soap and phenol may hamper the action of a septic tank by their effect on the anaerobic bacteria responsible for digesting the organic matter.

AQUA PRIVY

Sometimes called septic toilet, it consists of a squatting plate with a long drop pipe, extending into a water tight tank to a point well below the water level (Fig. 8.5). The tank is usually below the seat. Feces and urine decompose anaerobically and there is three fourth reduction in the solid mass which settles as sludge at the bottom. Liquid effluent undergoes further treatment in a seepage pit or subsoil irrigation system. Solid of the pit residue has to be

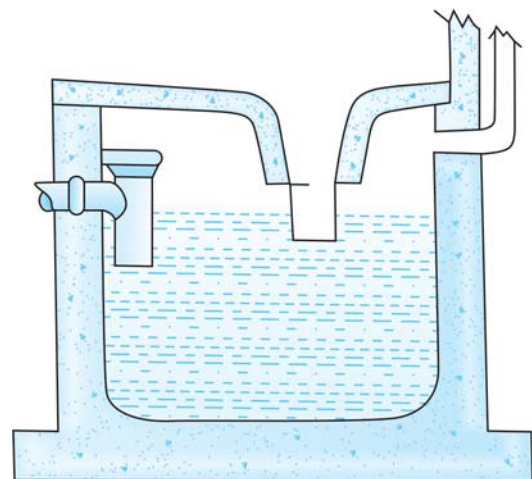


Fig. 8.5: Aqua privy

removed periodically. A vent pipe, 7.5 cm in diameter, extends above the neighboring structures. Aqua privy, if well constructed, can be located near dwellings and can still be esthetic without any danger to health. A tank of 1 cubic meter capacity can serve a family for 5 years.

SULABH SHAUCHALAYA

As the name “Sulabh” suggests, it is a simple system consisting of two pits with a sealed cover into which human waste is discharged from a toilet. The toilet uses very little water to flush the waste away. While open pit is in use, the other is a stand by. When one gets filled up, the waste flow is directed to the second. After 18 months, the human excreta in the first pit gets incorporated into the ground and may then be used as manure.

A Sulabh Shauchalaya is a water—flushed toilet connected to these twin pits. It is a handflush water seal latrine and is essentially an improved version of the RCA latrine having a pit size of about one cubic meter. It can be adapted to different hydrogeological and physical conditions.

The success of the Sulabh Shauchalaya movement lies in the fact that:

- The organization not only builds the latrines but also provides maintenance service for smooth functioning.
- The system is self-supporting in the sense that the maintenance costs are met through a pay and use system per person for single time use.
- In places where the number of latrines is large, biogas plants have been established to generate combustible gas and electricity from the excreta.
- It is a nongovernment effort using the approach of people’s participation and their perceived needs.

Thousands of Sulabh toilet complexes in slums and towns all over India are being used by 10 million people at present. This system has been recommended for adoption all over the Third World by WHO, UNICEF, UNDP and the World Bank.

Sewerage System

Sewerage system involves carriage of sewage, (all liquid wastes and human excreta) through a system of drains and sewers from the point of origin (houses, institutions and factories) to the point of disposal with the help of water. The essential requirements of the sewerage system are:

- Abundant supply of piped water
- Good natural gradient or fall to provide flow velocity
- Place for proper disposal of sewage effluent.

The responsibility of constructing and maintaining a sewerage system lies with the public health engineers. However, a medical student should know the outlines and the principles.

The sewerage system can be divided into 3 parts:

1. House drainage
2. Drains and sewers
3. Sewage treatment and disposal.

The water carriage system may be of two types.

1. Combined sewer system, where the sewage and the storm water are both carried together.
2. Separate system, where there are separate channels for sewage and storm water and the surface water from the streets is not admitted into the sewers. This system is the preferable one.

The various components of the sewage system will now be briefly described.

House Drainage

It includes sanitary installations that receive liquid wastes in the house and are connected with the house drain. They are:

1. Latrine, which in this system is called water closet (WC)
2. Bathrooms
3. Washbasins
4. Sinks
5. Storm or rain water pipe.

The above five components of house drainage are described below.

WATER CLOSET (WC)

It has the following parts:

Pan: It may be sitting or squatting in type.

Trap: It is a U shaped pipe connecting the pan with the soil pipe. It holds water in the bend and thus forms a seal to prevent escape of gases from the soil pipe into the privy. The height of water seal is 2-5 cm.

Flush cistern: It holds about 14 liters of water for flushing.

BATHROOM

Water is drained through a square or circular hole covered by a perforated iron plate. Sullage water drains into a gully trap in which silt settles at the bottom and the supernatant water passes out to the house drain.

WASHBASIN

Below the washbasin there, is a U-shaped trap. The silt or other coarse material gets caught at the bend and may have to be removed when necessary. The drain-pipe opens into the gully trap of the bathroom.

SINK

It receives kitchen waste water which contains garbage, silt and ashes. It is also connected with the gully trap which has to be desilted periodically.

RAIN WATER PIPES SYSTEM

Three types of pipes are usually seen on the outer wall of sanitary blocks in a building. The largest is the storm or rain water pipe which drains rain water from the roof into the gully trap (**Fig. 8.6**). The medium sized is the soil pipe while the small sized pipe is the sullage water pipe draining bathrooms and sinks.

Drains and Sewers

The house drain receives all sewage and sullage from the sanitary installations in the house. It is connected with the sewer or the larger drains in the street through an *intercepting trap*. The latter is a masonry tank having an open gutter or channel at the bottom. It connects the house drain on one side and the sewer on the other side through the bent that forms a water seal to prevent escape of gases from the sewer towards the house.

The sewerage system begins in high lying areas and proceeds to progressively downward areas. Where the slope is inadequate, instead of making the sewer deeper and deeper for gradient and velocity, it is economical to interpose a pumping station that lifts the sewage back to a higher level. The size and depth of drains and sewers go on increasing, upto the last outfall sewer near the disposal point. On all the turns of sewage lines or at every 100 meters distance, there is an inspection chamber or manhole.

Sewage Disposal

Sewage is 99.9 percent water and 0.1 percent solid matter, about half of which is suspended and half is in dissolved state. The bacterial content of sewage is very high. This is not surprising in view of the fact that one gram human feces contains 100 million *E.coli*, 10-100

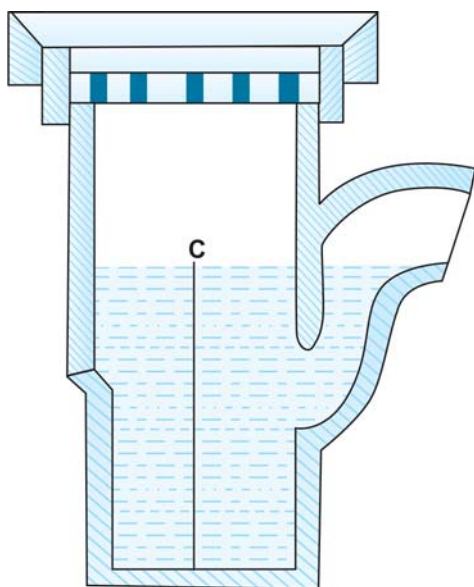


Fig. 8.6: Gully trap

million fecal streptococci and 1-10 million spores of *Cl. perfringens*, besides many other organisms, some of which are pathogenic. Hence raw sewage should never be discharged into rivers and streams without prior treatment. This is particularly so when the sewage is "rich" or strong, i.e. relatively concentrated. A major criterion to judge the richness of sewage is the biological oxygen demand (BOD) defined as the amount of oxygen in mg per liter of sewage absorbed over 5 days at 20°C for aerobic destruction of organic matter by living organisms.¹²

Typical values for strong, medium and weak raw sewage in mg per liter or parts per million (PPM) are given below:

	Strong	Medium	Weak
Total solids	1000	500	200
Suspended solids	500	300	100
Dissolved solids	500	200	100
Biological oxygen demand	300	200	100
Dissolved oxygen (All consumed by the organic matter)	0	0	0
Alkalinity	200	100	50
Fats	50	20	0

RAW SEWAGE DISPOSAL

Direct discharge of raw sewage into sea or rivers, though undesirable, is still a common practice. Sixty percent of Mumbai's sewage is discharged raw into the sea. Raw sewage disposal into rivers is the major cause of river pollution. An example is the 600 km stretch of Ganga from Haridwar onward which is particularly heavily polluted. Ganga Action Plan (GAP), the largest environmental project in Indian history, is aimed at tackling this problem. Its first phase (1985-1990) covered 27 big cities. The project was formulated to achieve economical viability through renovation of existing sewage treatment plants in such a way as to gainfully utilize the byproducts of sewage treatment, such as methane, biogas, manure and effluent water. A recent review shows that many targets of phase I remain unfulfilled.

SEWAGE DISPOSAL AFTER PURIFICATION

Treatment of sewage may be divided into four parts.

- 1. Preliminary:** Separation of heavy suspended and floating matter.
- 2. Primary:** Sedimentation and decomposition of organic matter into simple forms by anaerobic bacterial action.
- 3. Secondary:** Bioaeration or stabilization or mineralization of end products by aerobic bacterial action. Stabilization means complete breakdown of organic matter to simpler substances so that no further decomposition takes place.
- 4. Final:** Disinfection or destruction of pathogenic organisms.

PRELIMINARY TREATMENT

Screening: This is done by coarse and fine iron screens before sewage enters the pumping station. Screening removes big floating materials such as paper, straw and sticks.

Detritus chamber: After screening sewage enters this chamber where all heavy matter such as gravel and sand settles down. The grease and other fats floating on the surface have to be skimmed off, dried and burnt. Silt at the bottom is mechanically removed.

PRIMARY TREATMENT

This includes sedimentation and septic tank action.

Plain sedimentation tanks: As the sewage passes slowly through these tanks, suspended organic matter settles down as sludge. Coagulants such as alum or ferrous sulphate are sometimes added. The sludge has to be removed intermittently or continuously by mechanical means. Some degree of anaerobic decomposition of organic matter also takes place in these tanks. In 1-4 hours, on an average, 60 percent of the suspended matter and 35 percent of BOD is removed.

Septic tanks: Large circular or rectangular tanks are provided through which sewage passes slowly and is held for 8-24 hours. Both sedimentation and septic tank action take place here. There is formation of scum on the top; the effluent enters and leaves the tank below the surface without disturbing the scum. Sludge and scum have to be removed intermittently or continuously by mechanical means. The sludge needs further digestion and the effluent, still having suspended matter with high biological oxygen demand, needs further treatment such as bioaeration.

Many types of sedimentation and septic tanks are in use. The anaerobic or septic action decomposes the organic matter consisting of proteins, fats, cellulose, soaps, urea and mineral matter. Ammonia, phenols, aromatic and fatty acids are released. Ammonia is partly let off, and part of it combines with nitrous acid to form nitrites. Carbohydrates are fermented to alcohol or changed to butyric acid, and lactic acid, etc. Fats are ultimately hydrolysed to carbon dioxide and water.

SECONDARY TREATMENT

After primary treatment, the effluent still contains lot of organic decomposable matter that can be further broken down by aerobic bacteria. The aim of secondary treatment is bio aeration of the effluent from primary treatment. This can be done by two methods, viz. the Trickling filter method and the Activated sludge method.

Biological trickling filter method: The trickling filter is a bed of crushed stones. It is about 15-30 m in diameter and 1-2 m deep. The effluent from primary

treatment is sprinkled over this bed by a revolving device which consists of hollow pipes, each of which has a row of holes. The pipes, keep rotating, sprinkling the effluent on the filter bed. Over the filter bed a complex biological growth consisting of algae, fungi, protozoa and bacteria is formed. It is known as zooglia layer. The effluent that passes through this bed gets oxidised by the bacterial flora in the zooglia layer. From the under drain, the effluent goes to secondary settling tanks where sludge is removed from the bottom.

Activated sludge process: It is a modern method to treat the sewage. In this process the effluent after primary treatment is mixed with 20-30 percent activated sludge, which is a rich culture of aerobic bacteria obtained from the final sedimentation tank. This mixture is aerated for 6-8 hours. This is done by diffusing fine air bubbles from below (bubble aeration) or by mechanically stirring the sewage (mechanical aeration). The sludge that is formed amounting to 20 percent of the sewage is removed in secondary settling tanks. The effluent is pretty clear.

FINAL TREATMENT OF DISINFECTION OF SEWAGE

At the end of secondary treatment, the effluent, though clear, still has pathogenic organisms. If it is to be discharged into a river, it must be disinfected by the traditional or newer methods described below:

Chlorination

Chlorine or bleaching powder is added in a proportion of 2-5 PPM.

The residual chlorine content before discharge into the river must be 0.5 PPM.

Sewage Disinfection by Irradiation

This is a new method based upon nuclear technology. This technique is already being used in five countries. India is sixth country in the world and the first in Asia to use this method. The Sludge Hygienization Research Irradiator (SHRI) established at Gajerwadi, Baroda by the Bhabha Atomic Research Center in 1992, can take care of half of the city's sewage. It uses gamma irradiation from a Cobalt-60 source, which reduces the concentration of coliforms from 100 million/ml to negligible levels.^{12a}

OTHER METHODS OF SEWAGE DISPOSAL

These are as follows:

- Direct chlorination
- Sewage farming
- Oxidation pond (stabilization pond)
- Oxidation ditch.

These are briefly discussed below.

Direct Chlorination

If the four phases of sewage treatment described above cannot be used, the least that can be done is to chlorinate the raw sewage directly to a level of 5-10 PPM by adding chlorine or bleaching powder before discharging it into the river.

Sewage Farming (Surface or Broad Irrigation)

This method can be used for small communities where lot of land is available and soil is porous. After preliminary treatment (screening and sedimentation), the sewage is made to flow onto land on which ridges and furrows have been made. The sewage flows in the furrows while the ridges are used for growing fodder grass and suitable crops (which are not eaten raw). The discharge in an area has to be intermittent. One acre land is sufficient for sewage form 100-300 persons.

Stabilization Pond

Also called Oxidation pond, it is an old method, the importance of which has been only recently recognized.¹³ This method enables sewage purification by forces of nature at very low cost. It is being used at more than 50 places in India. Two examples are the oxidation pond at Sevagram, Wardha and Bhilai. The latter is a large one, catering to a population of one lakh.

Principle: The oxidation pond is characterized by the presence of the following three attributes:

- Presence of bacteria feeding on organic matter
- Presence of algae, and
- Presence of abundant sunlight.

The main action of the bacteria is aerobic. They degrade the organic matter to carbon dioxide, ammonia and water. These products are in turn utilized by the algae for their own growth. During the process of photosynthesis the algae utilize carbon dioxide and produce oxygen. This oxygen is the major source for the bacteria, making the aerobic decomposition of organic matter possible. Thus, it is clear that the aerobic bacteria and the algae are in a state of symbiotic relationship. In the deeper layers of the pond, where algal growth is minimal, and especially in late hours of night, some anaerobic decomposition by anaerobic bacteria also occurs. Thus, the oxidation pond purifies the sewage not only by oxidation (aerobic process) but also by reduction (anaerobic process). For this reason the name redox pond is technically more correct than the term oxidation pond. The most appropriate term, however, is “waste stabilization pond”.¹³

Construction: It is an open, shallow pool with a depth of 1-1.5 m. There is an inlet for sewage and an outlet for the effluent. The surroundings of the pond should be kept free from growth of vegetation and weeds. If

this is not done, mosquitoes may cause a menace. The pond must be located in an area with abundant sunlight.

Ideally, a stabilization pond should consist of three sequential ponds, water flowing from one to the other as follows.^{1a}

- 1. Anaerobic pond:** It is 2-5 meters deep and functions essentially as one open septic tank. It requires desludging after every 3-5 years. It receives strong raw waste with high BOD. Digestion here is almost completely anaerobic.
- 2. Facultative pond:** It is 1-2 meter deep. It receives water from anaerobic pond. Its deeper part is anaerobic. The upper layer is aerobic during day due to intense photosynthesis of phytoplankton, whereby oxygen is released. This layer is anaerobic during night due to respiratory oxygen demand.
- 3. Maturation pond:** It is 1-2 meter deep. It receives facultative pond effluent. The main function achieved here is reduction of excreted pathogens and nutrients. Some reduction of BOD also takes place here. It is aerobic at all times.

Aerobic and facultative ponds are used independently also, without the sequential flow system. These two are primarily designed to reduce BOD, while maturation pond is primarily designed to destroy excreted pathogens.^{1a} Fish can be cultured only in maturation ponds, which are aerobic all the time.

As a rule of thumb, if the overall retention time over a series of ponds is at least 20 days, the effluent is safe for fish culture from the point of view of public health. The area of stabilization ponds reported in literature varies from 400 m² nightsoil fed ponds in Jawa to 10 hectare sewage fed ponds in Munich. The most desirable size of sewage fed ponds in China has been found to be 3.3-6.6 hectare. Ponds in tropics are usually smaller, about 0.2-0.5 hectare.^{1a}

The effluent may be used for irrigation or may be discharged into river or sea after appropriate treatment. They may also be used for fish farming as already mentioned.^{1a} Since there is no fecal odor associated with these ponds they are an acceptable and suitable method for small communities.

Stabilization pond can be an economically sound proposition. Water hyacinth, a plant with scavenging potential, can help in water purification in a stabilization pond. This plant grows very fast. It can be removed and used for production of manure rich in nitrogen, phosphorus and potassium (NPK).

Oxidation Ditch

This is a method working on the same principle as an oxidation pond with the difference that mechanical rotors are utilized for proper and continuous aeration of sewage. The land area needed is hence less, about one twentieth of that for an oxidation pond.

Sullage Disposal

In towns and cities, sullage water is disposed of either in the sewer system or by the surface drainage system. In villages and isolated domestic habitations, proper arrangement for disposal of sullage water is needed to avoid haphazard water collections with the attendant problems of fly and mosquito breeding as also of nuisance of sight and smell.

SOAK PIT

In the absence of a drainage system in rural areas, sullage water spills and stagnates along open streets, leading to nuisance and unhygienic conditions, apart from acting as breeding source for mosquitoes. The soak pit is a cheap, simple and sanitary method of disposing sullage water. Besides acting as a sanitary sullage disposal system, the soak pit also acts as a device for recharging of ground water. Improvements in soak pit have been suggested by the Safai Vidyalaya, the Central Building Research Institute, Roorkee, and the Consortium on Rural Technology, Delhi. The steps in constructing an improved soak pit as suggested by the latter are given below:¹⁴

- Choose a proper site which should be away from a house wall and at least 10 m distant from any well. The water table should not be very high. Its water is present 3-4 m below ground level, this technology may not be appropriate.
- Dig a pit about 1 meter long, broad and deep. The bottom of the pit must have a slope of about 15 cm, the direction of the slope being away from the house.
- Divide the depth of the pit into roughly four equal parts. Fill the lowermost part with stones or bricks the size of a coconut. Fill the second part with stones or bricks the size of a big apple. The third part is to be filled with stones of the size of an average lemon. The fourth or uppermost part is for the inlet chamber.
- The inlet chamber is constructed as follows (**Fig. 8.7**):
 - At the center, lay the foundation of the chamber in the form of 4 bricks arranged as shown, laid with a gap of 5 cm between the bricks, leaving a central space of 12.5 × 12.5 cm (5" × 5").
 - Lay over these bricks a second layer of bricks without leaving any space between the joints.
 - If necessary, similarly lay a third or fourth layer of bricks. This will depend upon the slope of the drain from the source outlet of waste water to the inlet chamber of the soak pit.
- Take a 1 sq m gunny cloth with a hole in the center about the size of the inlet chamber. Cover the stone layer of the pit with this gunny cloth.

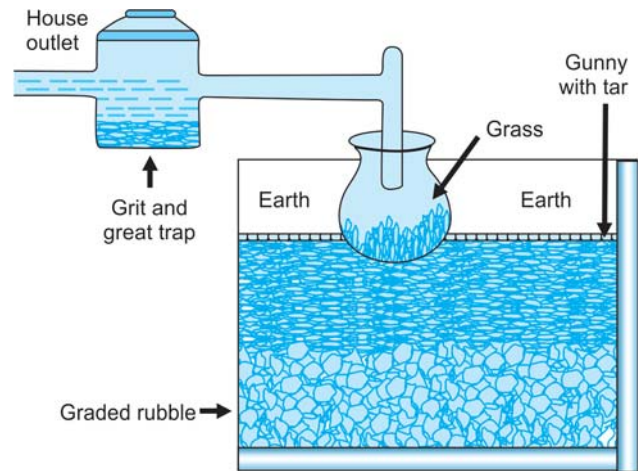


Fig. 8.7: Soak pit

- Cover the gunny cloth with a similar sized polythene sheet having a similar hole in the center.
- Cover the polythene sheet with soil and fill the pit. Compact the soil properly. The soak pit is now ready.
- Make a pucca drain 7 cm (3") wide and 10 cm (4") deep from the water outlet to the soak pit inlet. It should have a slope of about 8 cm per meter, i.e. about 1" per foot. The drain should be covered by bricks or flat stones without joining them. This helps in checking the entry of solid waste and rain water.
- Provide a trap near the middle of the drain to check the entry of suspended solid wastes from entering the pit. Dimensions of the trap are: length 35 cm (14"), breadth 25 cm (10") and height, progressively sloping along the flow of water, so as to be 25 cm (10") in beginning, 22.5 cm (9") in the middle and 20 cm (8") at end. At the middle is provided a partition with a 7.5 cm × 7.5 cm (3" × 3") hole at the bottom.
- Cover the trap and the inlet chamber of the pit with a flat stone.
- Cover the top surface of the soak pit with soil so as to raise it 5 cm above the surrounding ground level.

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9

Physical Environment: Place of Work or Occupation (Occupational Health)

Like the home and the school, the place of work is also an important part of man's environment. The physical, chemical and biological agents and the work environment at place of work may affect the health and efficiency of the worker. A man is exposed to these for at least six to eight hours daily at his place of work or occupation. This environment, therefore, should be healthy and free from any harmful agents as far as possible. A healthy occupational environment, in addition to being beneficial for the workers, is conducive to higher work productivity.

Occupational Health is an important branch of preventive medicine. It deals with: (i) promotion and protection of the health of the worker, (ii) early diagnosis and prompt treatment of occupational diseases and (iii) rehabilitation in case of disablement. The term 'occupational health', being more comprehensive, has replaced the old terms industrial hygiene, industrial health and industrial medicine. The subject envisages health, safety and welfare of all the workers alike such as office goes, farmers, unskilled laborers, teachers and workers in the cottage industry, etc. and not only those engaged in an industry. Factory workers, however, need and are paid special attention by the government because they work in hazardous environments and are exposed to special risks. In its first session held in 1950, the Joint ILO/WHO Committee on Occupational Health stated that the general aims of occupational health should be the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention among workers of departures from health caused by their working conditions; the protection of workers in their respective employments from risks resulting from factors adverse to health; the placing and maintenance of the workers in an occupational environment adapted to their physiological and psychological needs, or, in other words, the adoption of work to man and of each man to his job.

Most physicians are nowadays confronted with occupational diseases. They should hence be conversant with occupational health hazards. The various factors in occupational environment that may affect health are:

- *Physical agents* such as extremes of temperature and humidity, abnormal air pressure, vibrations, noise,

radiant energy, injurious force and friction from machinery parts.

- *Chemical agents* such as toxic substances and dusts.
- *Biological agents* such as *B. anthracis*, leptospirae, fungi, and scabei.
- *Social factors* related to work environment such as tension and worry related to coworkers and employers, job security and the conditions of employment.

Physicochemical Agents

In this chapter, we shall discuss the following:

- Physical (including chemical) agents in occupational environment
- Offensive trades and occupations
- Occupational diseases and hazards
- Prevention of occupational diseases
- Occupational health legislation
- Worker absenteeism
- Biological agents and social factors in occupational health.

Physical Agents

Temperature and Humidity

Exposure to extremes of temperature: Workers in the field, such as farmers, road builders and those engaged in house construction, are exposed to external heat from the sun. Fishermen and workers at high altitudes are exposed to cold.

Many workers are exposed to high temperatures inside the workrooms, such as those employed in engine rooms, metal works, cement, asbestos and abrasives factories, bakeries, brick kilns and potteries, etc. Workers in ice factories, cold storage rooms, milk dairies and cold laboratories are exposed to cold.

Effects of extremes of temperature include prickly heat, heat stroke, heat exhaustion and muscle cramps in case of heat and frostbite and respiratory diseases in case of exposure to cold.

Exposure to high humidity: It accompanies extremes of temperature in many industries and aggravates the heat or cold effects on body such as in textiles, paper factories, ice factories, etc.

Air Pressure

Aviators, balloonists and mountaineers are exposed to low pressure while deep sea divers, caisson workers and workers in submarines and deep mines are exposed to high pressure.

Acclimatization to heat, humidity and pressure has already been discussed in the Chapter on Air.

Vibrations

Industrial exposure to vibration occurs while operating machines and hand tools that impart vibrations. Common examples are grinding, burning, hammering, breaking concrete, cutting, chipping and scaling of metals, hole boring, drilling and tailoring, etc. Vibrations may cause general symptoms such as nervousness and fatigue or local symptoms such as injury and inflammation of bones and joints. The surrounding soft tissues such as nerves, muscles, tendons, ligaments and blood vessels may also be affected. As a preventive measure, hand held vibrating tools should be replaced by automation processes. Suitable job placement, periodic medical check up, rest and proper exercises are also necessary.

Noise

Like hypertension, noise has also been called a silent killer. This is so because the effects of noise are very insidious. It is estimated that 6 to 16 million workers in the USA work in noisy surroundings that may impair hearing.¹ Figures for India are not available. However, a study by the National Physical Laboratory indicated that Mumbai is 'the noisiest city in India', the biggest source of noise for a person there being vehicular traffic.¹ A recent survey in noise-prone industries (oils, textiles and steel mills, automobiles industry and railway workshops) revealed a noise level of 95 to 102 decibels.¹ Industrial noise ranging from 81 to 102 decibels numbs the efficiency of a worker besides being injurious to his health. It may be mentioned that as demonstrated by Theodore Wacks at Purdue University in 1982, ordinary household noise also can retard the cognitive development of children aged 7 to 24 months.¹ Even the foetus may suffer from undesirable effects of noise. A recent study advocated that pregnant women avoid prolonged exposure to noise.¹

Industrial noise may be classified into four categories as follows:

1. Steady wide band noise from continuously operating motors or machines.
2. Steady narrow band noise from saws, lathes and pneumatic hand tools.
3. Impact noise (lasting less than 1/10th of a second) from drop hammers.
4. Repeated impact noise from pneumatic hammers, riveting, etc.

EFFECTS ON HEALTH

Noise has wider ranging ill effects than the effect on hearing alone. There is enough evidence to show that noise has undesirable effects on cardiovascular, respiratory, endocrine and nervous systems. For example, abnormal cardiac rhythms have been found in workers exposed to intense noise in steel mills and ball bearing factories. Overexposure to noise is associated with high blood pressure, peptic ulcer, and, in general, a higher environmental stress.^{2,3} A noise of 140 decibels is sufficient to drive a person insane. As regards acoustic damage, prolonged exposure to noise levels greater than 85 decibels can impair hearing permanently. Studies conducted in USA in the fifties showed that the noise level in several prison industries varied from 75 to 110 decibels and the prisoners developed impairment of hearing within three months, which was permanent to some extent.¹ The temporary impairment of hearing due to noise trauma usually occurs in a frequency range of 4000 to 6000 Hz. (One Hertz denotes a frequency of one wave per second. Human ear can perceive sound between 20 and 20000 Hz).

NOISE CONTROL

The control of noise pollution and prevention of noise trauma can be achieved by using the following measures:

- *Reduction of noise production:* By using less noisy machines and by fitting noise mufflers and silencers.
- *Reduction of noise transmission:* By enclosing noise producing machines in thick walled sound proofed chambers. Noise in cities and towns can be markedly reduced by green belts having plantations of dense shrubs and trees like neem, banyan, casuarina and tamarind.¹
- *Protection of persons exposed:* To noise above 85 decibels at frequency above 150 Hz. Ear plugs and ear muffs can be used for this purpose. The workers in noisy environment should be rotated to avoid prolonged exposure and their hearing should be checked by periodic audiograms.
- *Suitable legislation:* To prevent noise pollution and to award compensation for noise trauma.
- *Appropriate health education:* To workers, employers and the general public about the effect of noise on health and the related preventive measures.

Noise pollution is also briefly discussed in the Chapter on Environmental Pollution.

The center has changed rules to prohibit or regulate noise from myriad sources, including the modern day menace of construction and blowing horns at night. The rules ban the use of vehicle horns, sound emitting fire-crackers, sound emitting equipment, noisy construction equipment in residential areas at night. Night time has been specifically defined as 10 pm to 6 am. Loud noise

from the neighbor's music system and parties has also been covered. Noise at the periphery of a public place such as a hotel or stadium should not rise above 10 dB of the ambient noise beyond its periphery. Noise emerging from a private place at its periphery should not exceed 5 dB above the ambient noise level at the periphery. Ten automatic noise monitoring stations in certain cities would be installed that will record ambient noise levels 24 hours a day to create noise maps for each city (**Table 9.1**).

Radiant Energy

It has various forms depending upon the wavelength of the electromagnetic waves, which varies from the very large wavelength of radio waves at one extreme (wavelength up to ten million meters) to the extremely short wavelength of cosmic rays (millionth of an Angstrom). The effects of various types of radiant energy are described below in order of decreasing wavelength (increasing frequency).

LONG WAVELENGTH RADIO WAVES

These are used for wireless transmission. These are not absorbed and are harmless to the body.

Microwaves

They are short waves used in radar communications on ships, aeroplanes, etc. They raise the temperature of tissues. The lens of the eye is very susceptible and cataract may develop on excessive exposure.

INFRARED RADIATION

Outdoor exposure may occur in case of farmers and sailors who are exposed to too much sun. Indoor exposure may occur to glass blowers in glass industry where hot molten glass emits infrared rays. Blast furnace workers, blacksmiths, kiln and oven workers and stokers are also exposed to infrared rays. These rays raise the temperature on getting absorbed. The lens of the eye and the retina are specially sensitive. Intense exposure to infrared rays leads to cataract.

LIGHT RADIATION

Visible light may be in the form of natural sunlight or artificial light. Ordinary light from electric bulbs and

tubes has no ill effect within reasonable limits of exposure. Bright, sharp and direct light produces glare which may cause eye strain, fatigue and headache. Poor lighting may lead to accidents, hence highways, gangways, hallways and machine rooms should be well illuminated. The standards of lighting should be fixed. Indirect illumination by reflected light from a hidden source is comfortable and does not have a shadow producing effect. However, it reduces intensity by 25 to 50 percent.

All efforts should be made to maximise the use of *natural sunlight*. This can be done by providing plenty of windows and sky lights (glass area at least 20 percent of floor area) and by painting the walls white.

ULTRAVIOLET RADIATION

The most important source is the sun, whose ultraviolet rays have a wavelength of about 200 millimicrons. Ultraviolet radiation is greater at high altitudes than at sea. Earth's surface absorbs a part of the sun's ultraviolet light, but snow reflects 75 percent of ultraviolet radiation. This explains why persons skiing over snow get severe sunburns even on the underside of nose which is not exposed to sun. Farmers, shepherds, sailors and road builders also are prone to excess ultraviolet radiation due to constant exposure to sun. An indoor source of ultraviolet radiation is the mercury vapour discharge tube, which is widely used for ultraviolet radiation. It gives many times more radiation than sunlight. Ultraviolet light is also emitted by carbon arcs, electric welding and other sources to which electricians, welders, metal moulders and atomic energy investigators, etc. are exposed. Hence, the need for proper protection of eyes in case of welders.

EFFECTS OF ULTRAVIOLET RADIATION

It does not penetrate more than a few millimeters and is almost entirely absorbed at the surface of the body. Its direct effect is, therefore, only on the skin and eyes. All other effects are due to changes in these tissues. Effects on the skin include erythema, darkening of the skin (suntan) and thickening of epidermia as a protective mechanism depending upon the duration and intensity of exposure. Prolonged exposure may result in squamous cell carcinoma or basal cell epithelioma (rodent ulcer).

Proper clothing is adequate to protect the skin against ultraviolet light. Effects upon the eye include keratitis caused by absorption of ultraviolet light by the cornea. Light reflected from snow can cause the same lesion, sometimes referred to as snow blindness. A similar lesion can occur from flash burns in arc welding. Special glasses that filter ultraviolet and infrared rays should be worn to protect the eyes from radiation injury.

TABLE 9.1: Existing limits of sound*

Zone	Day (dB)	Night (dB)
Residential	55	45
Sensitive	50	40
Industrial	75	70
Commercial	65	60

*Environment and Forest Ministry. Government of India

IONIZING RADIATION

It is of two types—particulate radiation (alpha particles, beta particles and neutrons) and electromagnetic radiation (X-rays and gamma rays). On entering the body, ionizing radiations damage the cells by causing ionization, particularly in the nucleus. The examples of occupational exposure to ionizing radiation are as follows:

- Persons working in departments of radiology, radiotherapy and nuclear medicine are at risk of excess exposure.
- Painters of which radium dials are exposed as they moisten the brush with the tongue.
- Radioisotopes are used in industry to find flaws in casting and to detect the content of metallic containers
- Soldiers may be exposed to nuclear explosions for military purposes.

HAZARDS OF IONIZING RADIATIONS

Pregnant women and children are more prone to radiation hazards. The extent of damage depends upon:

Tissue Involved

Highly sensitive cells are lymphocytes, bone marrow cells and gonadal cells.

Type of Radiation

Both alpha and beta particles are harmful if injected or inhaled. Beta particles can affect the skin also. X-rays have high penetrating power and affect skin as well as internal organs. Gamma rays cause even more damage.

Area of the Body Exposed

Irradiation of large area of the body may lead to death in days to weeks because of bone marrow depression. Radiation dose is several million times the average daily dose received from natural sources and occupational or medical exposure.

Acute Exposure

Massive doses of penetrating radiation such as X-rays and γ -rays may cause death in a few hours or days. In less severe cases, loss of appetite, nausea and vomiting occur within an hour or two. Symptoms may subside after one day to two weeks, but reappear after a latent period in the form of diarrhea, fever, bleeding and ulceration of mucous membranes, fall in blood pressure, increased susceptibility to infections, epilation, amenorrhea, increased capillary fragility and marked decrease in blood cells, especially lymphocytes and polymorphs.

Chronic Exposure

Cancer: Various types of cancer may be induced, particularly of lung, blood and skin, leukemia is a frequent result of repeated exposure, a significantly higher rate

being noted among radiologists. Powel found increased incidence of leukemia and other neoplasma in children followed upto ten years after their mothers received diagnostic X-rays during pregnancy.

Genetic effects: Genetic mutations are well known to occur in experimental animals and to a certain extent, in man as well. Radiation mutation being recessive, the chance of its manifestation in future generations is small. In 95 percent of such cases the offsprings dies during gestation or soon after. In the remaining 5 percent, the mutation is mainly in chromosomes other than sex chromosomes.

Shortening of lifespan: This has been statistically proved.

Skin lesions: Beta particles and low energy (soft) X-rays are responsible for most of the damage to skin because they are absorbed at the surface. High energy (hard) X-rays and gamma rays penetrate readily, hence the skin is usually spared. The skin reactions appear after a latent period of a week or two as erythema, edema, pruritus, blisters, sloughing of epidermis and ulceration. Healing is slow. Delayed effects include hyperkeratosis, atrophy of sweat and sebaceous glands and, eventually, epidermoid carcinoma.

Cataract: It can be caused by neutrons.

Prevention of radiation hazards: Strict adoption of known preventive measures is essential in order to avoid or minimize radiation injury as described ahead.

Protection against External Source

Shielding: The source of X-rays, γ -rays and particulate radiation should be surrounded by radio protective material of suitable thickness such as lead and concrete. Lead boxes are used to keep radium needles. Lead glasses are used in the window panes of diagnostic and therapy rooms. The cobalt unit used in the treatment of cancer is kept in thick concrete walled chambers. Lead rubber aprons and lead rubber gloves should be used by X-ray technicians in radiology departments.

Distance: The intensity of exposure varies inversely with the square of the distance from the source. Hence controls should be as distant as possible from the source of radiation so that the operator is exposed to the minimum. Long forceps should be used to handle radium needles.

Duration and extent of exposure: The maximum permissible dose of radiation fixed by the International Commission on Radiation Protection (ICRP) should not be exceeded (**Table 9.2**). The personnel employed should be adequate and they should be rotated in such a manner that no single person is exposed for a long time.

Monitoring devices: Film badges or personal dosimeters should be worn by the workers exposed so

TABLE 9.2: Maximum permissible doses for occupationally exposed persons over 18 years of age, and the public at large (ICRP)⁴

<i>Exposed part of body</i>	<i>Occupationally exposed persons</i>	<i>Public at large</i>
Whole body, blood forming organs and gonads	5 rems/yr or 3 rems/quarter	0.5 rems/yr
Bone, thyroid, skin	30 rems/yr or 15 rems/quarter	3 rems/yr
Hands, forearms, feet and ankles	75 rems/yr or 40 rems/quarter	7.5 rems/yr
All other organs	15 rems/yr or 8 rems/quarter	

ICRP: International Commission on Radiation Protection

that the degree of exposure may be continuously monitored.

Maintenance of plants, equipment and shields:

These should be checked regularly to detect any leakage.

Protection against Entry (By Inhalation, Ingestion or through Intact or Abraded Skin)

- Radio-contamination of air should be prevented by enclosing or encasing the radiation generating plant and by providing it with an exhaust system. Floor and walls should be wet mopped and not swept dry.
- Drinking water and food should not be kept or consumed in workrooms.
- Radioactive wastes should be properly disposed. Radioactive dust cannot be let off into water or air, nor can it be burnt or chemically treated. Gaseous and air-borne radiation should be controlled by filtration and dilution with air. Liquid radioactive material should be allowed to decay to the lowest possible level and then disposed of by filtration and dilution with water. Dangerous wastes are stored and buried. If let into drains, they should not go into the common sewers.

Technical Supervision and Monitoring

These should be directed by a health physicist in atomic energy establishments and by an industrial hygienist in industries where the hazard is low. The duties of the health physicist include designing plants and equipment, making frequent radiation surveys, providing and reading monitoring devices, imparting health education, undertaking research on safety measures and examining the issue and transport of radioisotopes.

Medical Supervision

Medical check up and blood count should be done before employment and at regular intervals after employment. Analysis of expired air and examination

of urine and feces may be performed as necessary to find the concentration in the body. Records should be kept properly and analyzed. Whenever an adverse effect is detected in a worker, he should be moved away from the site of exposure. Fluoroscopic and X-ray examinations should be withheld in pregnant women and children as far as possible.

Force and Friction

These constitute an important cause of injuries and accidents in industries. The damage depends upon the force with which a moving, projecting or revolving part strikes the worker. The presence of other physical factors such as heat, lighting and noise may adversely affect the likelihood of occurrence and the severity of such injuries.

Study of accidents and their prevention is an important subject for an industrial physician. The incidence of accidents is steadily rising. Mainlining quarries, construction works, railway workshops and heavy industries such as steel are particularly known for accidents. Age, sex, habit, personality and physical and mental state of the worker play an important role in occurrence of accidents. An industrial health team consisting of an industrial physician, an engineer, nurse and social worker should study the cause of each and every accident and should try to prevent further occurrence. More than 90 percent of accidents are preventable. Preventive safety measures such as proper fencing, encasing and care of machine parts are described in Chapter IV of the Factories Act, 1948.

Chemical Agents

Chemical agents responsible for occupational diseases form a long list and their number is ever increasing. They may occur in the form of dusts, fumes, mists, vapors and gases produced during various industrial processes as described below. This topic is further discussed in the chapter on environment pollution.

Dusts

They are solid particles generated on handling, crushing and grinding of rocks, ores, metals, coal, wood and grain, etc.

Fumes

They are solid particles generated on volatilization of liquids.

Mists

They are suspended liquid droplets produced by splashing, foaming or atomising. Examples are chromic acid mists in electroplating industry and oil mist from lubricants.

VAPORS

They arise in gaseous form from substances normally in solid or liquid state. Examples are vapors of hydrochloric, sulphuric, nitric and hydrofluoric acids. Mercury vapours are particularly hazardous in industry.

GASES

Important examples are sulphide, hydrogen cyanide, carbon dioxide, carbon monoxide, ozone and oxides of nitrogen. *The Bhopal gas tragedy* occurred on December 3, 1984 because of accidental chemical explosion in a tank leading to emission of MIC (Methyl Isocyanate) gas. This caused injury not only to the factory workers but also to a large number of people residing in Bhopal. It is estimated that 20,000 persons have died so far due to exposure to MIC. A high proportion (62%) of exposed persons showed simultaneous involvement of respiratory, gastrointestinal and central nervous systems and vision.⁵ The Bhopal gas tragedy was the world's worst industrial disaster caused in India by a US based multinational, Union Carbide. It may be mentioned that the company's own sister plants in USA were built to much safer design than the Indian plant. Also, the highly toxic chemical MIC was stored in the Bhopal plant in quantities unheard of in the West.

Effects of Chemical Agents

The main organs directly exposed to chemical agents are skin, respiratory tract and gastrointestinal tract. The effects on these organs are summarized below.

EFFECTS ON SKIN

The occupational skin diseases include—dermatitis, eczema and urticaria caused by resins and plastics, inorganic insecticides and other irritants; ulcers caused by acids, alkalies and chromates; and cancer caused by anthracene, asphalt, creosote, crude paraffin, pitch, soot and arsenic. If the chemicals are absorbed from the skin, they may even produce systemic effects. Notable among such chemicals are amine derivatives like aniline and alpha-naphthylamine and nitroderivatives like trinitrotoluene.

EFFECTS ON RESPIRATORY SYSTEM

Toxic agents entering by inhalation may be soluble or insoluble. Soluble dusts and fumes of lead, cadmium, zinc, manganese and magnesium are systemic poisons. They cause metal fume fever. Insoluble dusts cause different types of pneumoconiosis. Thus quartz dust causes silicosis, coal dust causes anthracosis, cotton dust causes byssinosis and asbestos causes asbestosis. Some gases like nitrous oxide, methane and carbon dioxide are simple asphyxiants and simply replace oxygen in the

lungs. Some gases are chemical asphyxiants such as carbon monoxide, hydrogen cyanide and hydrogen sulphide. Some others are irritants such as ammonia, chlorine, NO₂, SO₂ and ozone. Gases like arsine, phosphine and carbon disulphide are systemic poisons. Chromates, asbestos, beryllium, mineral oil and coal tar cause cancer.

Effects on Gastrointestinal Tract

Toxic agents or substances may be ingested with water and food. Lead, arsenic, chromium, cadmium and phosphorus poisoning may be caused in this manner. These substances are mostly excreted with feces but are partly absorbed into circulation.

Biological and Social Factors

Biological Agents

Workers in certain situations are more prone to some infections as an occupational hazard. Examples of such infections and the concerned environment are bilharziasis in rice fields; hookworm in manured fields; histoplasmosis, coccidiomycosis, blastomycosis and tetanus in soil in general and leptospirosis in mines. Tanners, veterinary personnel, zoo and circus attendants, farmers, butchers and pigeon raisers are exposed to occupational zoonoses such as anthrax, brucellosis, fever, psittacosis, mycotic infections and some parasitic infections. In addition, medical and paramedical personnel and veterinarians engaged in the care of persons or animals suffering from infectious diseases also run the risk of contracting them as an occupational hazard. Examples are serum hepatitis and AIDS.

Social Factors

Tension and worry often arise from social environment, i.e. from coworkers and employers, when a worker cannot adjust with them. Jealousy in promotion, nature of work, hours of work, less pay, poor housing, separation from family, lack of medical care and several other such factors disturb the mind and affect the efficiency and health of the worker as also his work productivity. The labor welfare officers and departments and the labor organizations aim at reducing such conflicts in the industries.

Offensive Trades and Occupations

Some trades and occupations, apart from being injurious to the health of the workers and other people, are offensive to sight, smell or hearing, they are called

offensive trades because of their nuisance and offensive character. They should hence be located far from residential areas. Their effect on health may be direct or indirect, immediate or late. The ill effects are due to:

- Dust, noise or obnoxious smell coming out of the manufacturing plant.
- Offensive sight.
- Effluent which, on accumulation, breed insects like mosquitoes and flies.

Common ones are described here in brief.

Keeping of animals: This trade causes nuisance of smell and sight due to stagnation of animal excreta. In addition, there is breeding of flies, mosquitoes and other insects.

Slaughtering of animals: Putrefaction of offal and continued flow of blood, urine and excreta produce offensive stink. The trade attracts dogs, rats and flies.

Blood boiling and drying: For obtaining albumin, red pigments and manure and for refining sugar. The hydrogen sulphide produced has a very offensive smell.

Bone boiling: To prepare phosphate manure for tea gardens involves offensive smell and sight. Bone stocks attract flies and animals.

Gut scraping: For making sausages and catgut.

Animal fat and tallow melting: To make candles, leather dressings, lubricants, etc.

Tanning: This industry involves soaking of animal skins and hides in water and later drying them in the open.

Paper industry: Which involves soaking cotton or linen rags, waste paper, straw, rice, husk, sugar cane, trash, grass, etc. for conversion into pulp. The workers are exposed to all sorts of dusts and flies. The alkaline and colored effluent spoils land and waterways and causes nuisance of smell and sight. Its disposal is a great problem in most cases.

Oil mills: When coconut, groundnut and oil seeds such as linseed and mustard are expressed in crushers, there is an offensive smell of oils and decaying wastes.

Rice mills: Steaming of paddy, soaking, drying, etc. give rise to offensive smell. Rice and flour mills cause noise in addition.

Occupational Diseases and Hazards

Detailed study of occupational diseases, their prevention and control is the special responsibility of the industrial physician. However, the medical student should be familiar with conditions like lead poisoning, pneumoconiosis, occupational hazards of agricultural workers, occupational dermatitis, radiation hazards, occupational cancer and industrial accidents. The first three are described below, the next two have already been discussed,

while the last two will be taken up in Chapter 21 as part of the sections on cancer and accidents.

Lead Poisoning/Plumbism

Lead is the most important cumulative poison. It may enter the body through:

- *Ingestion* of minute particles of lead in organic form such as tetraethyl lead, which forms lead chloride in the stomach and becomes readily soluble.
- Inhalation of dust and fumes of lead. Special mention needs to be made here of the lead released in automobile exhaust. In big cities like Delhi, Mumbai and Kolkata, automobile exhaust forms a major source of lead pollution. It is particularly dangerous for children since it can cause brain damage.⁶
- *Absorption from skin* especially when mixed with oil. Paints are a common source.

Lead is used in many industrial processes. Common examples of industries with a high risk of exposure to lead are as follows:

- Lead mining, smelting and manufacture of red, white and carbonate lead.
- Manufacture and use of paints, colors and dyes.
- Foundries.
- Manufacture of colored glass and lead gloves, aprons and screens for use in X-ray departments.
- Pottery.
- Manufacture of batteries.
- Manufacture of lead pipes and lead plates.
- Plumbing in relation to water supply, drainage, etc.
- Printing.
- Ship industry.

Main clinical features are lead colic, mottling of teeth, spongy gums, softening of bones and nerve palsies. Diagnosis can be made by the characteristic basophilic stippling of RBC and by assessing levels of lead in blood and urine. Urinary coproporphyrin and amino levulinic acid levels are also useful in diagnosis.

PREVENTIVE MEASURES

These may be described under the following headings.

Minimizing Environmental Pollution by Lead

- Substitution of lead compounds by less toxic materials where possible.
- Prohibiting the use of lead as an antiknocking agent by vehicle owners.
- Properly enclosing and shielding the machines or areas in an industry where lead is used.
- Proper exhaust ventilation to remove lead fumes. A safe environment should not have more than 2 mg lead per 10 cubic meter air.

Personal Protection

- Proper washing of hands by workers exposed to lead. This is particularly important in case of printing press workers who manually handle lead type for composing the matter to be printed.
- Use of appropriate respirators by workers exposed to lead fumes.
- Wet sweeping of floors and machines in factories using lead.
- Keeping the paints and other lead containing materials away from children's reach.
- Buying toys without lead paint for children.

Periodic Examination of Workers

This includes medical check up for early diagnosis of toxic symptoms, examination of blood for basophilic stippling and testing the response of external digitorum communis to electrical stimuli. Other tests as described above may also be used.

Pneumoconiosis

The term pneumoconiosis refers to a group of lung diseases caused by inhalation of insoluble dusts. Dust particles above 10 microns in size settle down from the air. The inhaled air thus contains only smaller particles. Particles 10 to 5 microns in size are caught in the upper respiratory tract and those measuring 5 to 3 microns are held in the mid-respiratory passages. It is the particles of size 3 to 0.5 microns that reach the smaller passages and cause pneumoconiosis.

Pathogenesis

The particles inhaled are lodged in lymphatics, lymph nodes, bronchioles and alveoli. The clinical picture depends on damage to bronchioles and alveoli followed

by development of fibrosis. The lung becomes predisposed to tuberculosis, which is often superimposed.

Clinical Features

After a varying latent period the characteristic symptoms and signs appear in the form of chronic cough, progressive dyspnea and emphysema. Cough may be productive and hemoptysis may occur occasionally. Tuberculosis is a common complication.

The severity of disease depends on the nature and size of dust particles, their concentration in air, the period of exposure and the host factors. Common pneumoconiosis and their causative agents are listed in **Table 9.3**.

While the role of asbestos which has over 3000 industrial applications is well known, it is only recently that the harmful effects of certain clay minerals naturally occurring in a fibrous state have been recognized. Among these are *attapulgit* and *sepiolite*. Clay fibers are used in many technological processes related to adhesives, fertilizers, cosmetics, pesticides, rubber, cement, etc. because of their absorptive and colloidal properties. Attapulgit can cause pulmonary fibrosis and can enter the body through respiratory tract as well as through gastrointestinal tract.⁸

Prevalence

Silicosis was first described in India from Kolar gold mines in 1947. It has now been found to be widely prevalent in many industries. Its prevalence has been reported to be 34.1 percent in mica mine workers and 15.7 percent in ceramic and pottery workers while that of *byssinosis* has been found to be 7 to 8 percent.⁹ Silicosis is a major occupational hazard for the workers in stone crushers. There are about 100 stone crushers in Delhi, responsible for 2 deaths per month due to environmental pollution. It has been estimated that a

TABLE 9.3: Pneumoconioses

Disease	Dust	Industries
<i>Mineral Dusts</i>		
• Silicosis	Silica	Gold, silver, mica and steel industry, slate and stone quarries, stone crushers and potteries
• Asbestosis	Asbestos (hydrated magnesium silicate)	Asbestos is an incombustible fibrous material used in the manufacture of asbestos cement roof tiles, brake linings, fireproof textiles, talcum powder, etc.
• Siderosis	Iron	Iron mines, steel works
• Anthracosis	Coal dust	Coal mines
<i>Vegetable Dusts</i>		
• Byssinosis	Cotton fibre (Cotton dust)	Textiles
• Bagassosis*	Bagasses or sugar cane dust	Cane sugar factories, paper and cardboard factories where bagasse or sugar cane fibre is used
• Tobaccosis	Tobacco dust	Cigarette, cigar and beedi industries
• Farmer's lung	Hay and grain fiber	Agriculture

*Bagassosis is now known to be caused by a thermophilic actinomycetes for which the name *Thermoactinomyces sacchari* has been suggested.⁷

500 tonnes capacity stone crusher emits three tonnes of suspended matter every day, the dust concentration in air around these crushers being 3000 to 8000 microgram per cubic meter air, compared to the permissible limit of 200 micrograms per cubic meter as prescribed by the Central Water Pollution Control Board.

PREVENTIVE MEASURES

- Modification of the manufacturing process.
- Prevention of dust formation by use of oil, water or steam and by water spraying and wet mopping of floors and walls.
- Prevention of escape of dust by enclosing the machinery emitting dust with special cabinets and boxes.
- Removal of dust by suction fans and exhaust shafts and by proper ventilation.
- Prevention of entry of dust into body by use of face masks, etc.

Occupational Hazards of Agricultural Workers

The reasons for preferring the term occupational health to industrial health were explained at the beginning of this chapter. The unsuitability of the terms, industrial medicine and industrial health is best illustrated by the fact that these leave out of their purview the largest sector of workers—the farm workers or farmers—in agricultural country. The occupational health hazards of farmers have been mentioned at several places in this chapter. It is worthwhile listing them together for sake of clear understanding. These may be described as follows:

- *Physical hazards:* Due to extremes of temperature, ultraviolet radiation, noise and inadequate ventilation.
- *Chemical hazards:* Due to fertilizers, insecticides and pesticides. The main pesticides used are DDT, BHC, aldrin and dieldrin. About 14,000 tonnes of DDT are annually sprayed in India and it has been found to be “ubiquitous” in soil, water, cereals, vegetables, fruits, milk, eggs, etc. Some studies suggest close correlation between use of pesticides and incidence of limb deformities, joint dysfunction and visual disabilities. Many of these chemicals are potential carcinogens. Various types of pneumoconioses, including farmer’s lung, are also examples of chemical hazards. It may be emphasized that insecticide poisoning is a very important and serious hazard for farmers. For example, 200 persons in 40 Karnataka villages were crippled in 1975 when they consumed fish and crabs collected from rice fields that had been sprayed with parathion and endrin.¹⁰

Another example of a pesticide acting as occupational hazard is aluminum phosphide. Poisoning with this chemical was unknown till 1981, but has now become the most common cause of suicidal poisoning in Haryana, a predominantly agricultural

state.¹¹ The pesticide is very cheap and is freely available. One to four tablets are sufficient to cause death, which occurs within 2 to 96 hours.

According to WHO estimates, one million people are globally affected by chemical pesticides every year and 20,000 of them die. 15000 of these deaths occur in the developing countries, though these countries use only one-sixth of the chemical pesticides used worldwide. One approach to this problem lies in developing and promoting the use of biopesticides which are living organisms that control pathogenic organisms. Their share in global pesticide market is expected to increase from the current level of about 5 percent to about 10 to 15 percent within a few years.

Biological hazards: Due to various infections like anthrax, brucellosis, tetanus, fever, hookworm, etc. as already described.

Accidents: Due to farming tools, mechanised equipments, snake bite, dog bite and other trauma from handling of farm animals. Amputations due to thresher injury are very common.

Other Occupational Hazards

Beedi workers, whose job involves rolling and tying of beedis, are constantly exposed to tobacco. Of the nine lakhs beedi workers, half are women. Tobacco exposure leads to mucosal damage manifested by conjunctivitis and rhinitis. Women also show fatal abnormalities. Dangers of exposure to pesticides and other chemicals have been described earlier. These dangers are accentuated in women because of their higher physiological vulnerability during pregnancy and lactation. Traffic policemen in metropolitan cities, posted at busy intersections, are exposed to very high levels of pollution. Their blood carbon monoxide level is 20 times higher than that found in office environment, according to a recent study conducted by AIIMS in collaboration with the Central Road Research Institute.¹² As per the findings of this study, the concentration of oxides of nitrogen at busy intersections was 5 to 12 times higher than in the office environment. Particulate matter concentration was found to be 2 to 6 times higher. This particulate matter emanated from vehicle exhaust as well as from the wear and tear of tyres and brake linings. The particulate matter can penetrate into the respiratory system causing lung tissue irritation and long term disorders. Diesel particles may even be carcinogenic. According to the US National Academy of Sciences, the risk of developing cancer in individuals exposed to diesel exhaust may be 1.42 times more. As regards gaseous pollutants, mention also must be made of ozone which is formed as a result of reaction between hydrocarbons and organic compounds. It causes eye, nose and throat irritation and may increase the susceptibility to infectious and pulmonary diseases. The

net result of the above is that a higher percentage of traffic policemen suffer from lung disorders such as tuberculosis. The prevalence of lung disorders among those exposed for more than 8 years to busy traffic conditions was 2.7 times more than in those exposed for a lesser period. The traffic policemen were also found to have more risk of impaired hearing due to noise pollution. The noise level was found to vary between 76 and 82 decibels at various intersections compared to the maximum recommended level of 65. Furthermore, the maximum allowable duration of noise exposure at these traffic crossings is 2 hours while the traffic cops have to put in a minimum of 8 hours.¹²

Prevention of Occupational Diseases

Specific prevention of some occupational diseases has already been discussed. Prevention of occupational diseases in general may be discussed under the following five headings as per the classical approach of preventive medicine.

HEALTH PROMOTION

Like any other segment of population, workers in different occupations should have positive health. Measures recommended are as follows.

- *Pre-employment or preplacement examination*, both medical and general, for adapting the job to the worker and the worker to the job. The worker should be assigned the job in which he fits. If he gets job satisfaction, he will give better output and will keep fit physically and mentally. Thus a man with potential hernia should not be assigned the job of weight lifting and a person with colour blindness or poor vision should not be employed as a driver.
- Carrying out *periodic health check up* and giving advice on nutrition, oral hygiene, rest and recreation.
- *Promotion of mental health*: Workers' problems at home or at the job should be studied and solved. Otherwise they may develop emotional difficulties which may reduce work output and may make the worker prone to accidents.
- *Health education*: Each worker should be educated in healthy habits such as washing and cleaning and should be educated to avoid hazards attached to his job.
- Provision of *healthy physical environment* is important. This includes good lighting and ventilation, effective temperature, washing and toilet facilities, and cleanliness at place of work.
- Provision of *welfare facilities* such as insurance against loss of job, illness and disablement, MCH and family welfare services, creche, place for having rest, changing clothes and having meals and then first aid.

Recreation grounds and clubs.

- Limiting long *hours of work*, provision for rest between work periods and liberalization of leave rules.
- Provisions of *good housing*.

SPECIFIC PROTECTION

This is done through specific measures which are partly medical in nature but, to a large extent they are related to engineering measures.

Medical Measures

- Immunization and other specific measures against biological agents such as BCG vaccination against tubercle bacillus, use of shoes against hookworms, etc.
- Protection of body against physical agents has already been dealt with. Protection against chemical agents is done by:
 - Protecting skin by suitable clothing, gloves, shoes, barrier cream, etc. and by washing hands and body with soap and water
 - Preventing inhalation by use of face mask
 - Preventing ingestion by not taking food at the place of work, washing hands properly before taking food and rinsing of mouth.
 - *Health education*: The worker is educated about the particular occupational risks and about the use of protective measures.

Engineering Measures

- Designing and construction of work place having enough space, light, ventilation and comfortable temperature.
- Proper designing, layout, maintenance and regular check of machines. Machines may be encased or enclosed if feasible. They should have minimum projecting parts.
- Modifications of machines and processes so as to minimize their hazards.
- Training and education of workers.
- Appropriate measures to minimise the production and spread of harmful agents (e.g. local exhaust system for dusts).
- Cleanliness of work rooms and premises.
- Research on offensive and hazardous machines, materials and processes.

It may be mentioned that every industry creates pollutants in the form of smoke, effluents, noise, etc. Pollution control requires the installation of sophisticated and expensive equipment. However, the social costs of pollution are far more significant. These include poor health and the associated reduction in productivity of people and the quality of life, the strain on medical services, corrosion of buildings, degradation of land, and the effect on flora and fauna which cause uncorrectable imbalances. These costs are not only inevitable but much higher than for installing pollution control technology.

EARLY DIAGNOSIS AND TREATMENT

There should be an occupational health team consisting of an occupational physician and others depending

upon the nature of occupation. The team should: undertake repeated surveys and periodical medical check-up, investigate any occupational injury or disease, and recommend measures for prevention and control. Any injury and disease, acute or chronic, found by the occupational health team or reported otherwise should be treated promptly and adequately. The worker's job may have to be changed if necessary.

DISABILITY LIMITATION

Any worker detected to have developed the slightest degree of disability due to an occupational hazard should be immediately assigned some other suitable job which may be free from the particular hazard. Other specific measures may also be needed.

Rehabilitation

If an employee has been handicapped after injury or illness, he should be given a suitable job to prevent psychological trauma and to ensure his productivity as a worker.

Occupational Health Legislation

There has been a tremendous growth of industries in India after independence. As a result the problems of health and safety for industrial workers have multiplied manifold. A large number of workers are employed in establishments not coming under the purview of the Factories Act. They are deprived of health, safety and welfare benefits available under the Act. They are deprived of even the basic amenities like drinking water and toilet facilities. Health cover for such workers is patchy and inadequate except in a small number of progressive industrial concerns and in the nationalized undertakings like State Transport and Railways. The majority of the industrial concerns either cannot afford, or are not interested in giving total health care to the workers. History reveals that the industrial revolution in the West paid heavily in the form of ill-health, accidents, deformities, tuberculosis, etc. This is a warning to planners in this country. The responsibility for health, safety and welfare of the workers should rest with the employers and the Government. The Director General, Factory Inspection and Advisory Service, advises the government, the industries and the others concerned, about matters related to health, safety and welfare of the workers.

The State protection to factory workers in India has been ensured through various Central Acts, the most important of which are the Factories Act, and the Employee State Insurance Act. Only the extracts of these Acts are given below to illustrate the health, safety and welfare facilities provided so far by legislation. The Rules in this connection are framed by the State Governments.

Factories Act, 1948

It came into force on April 1, 1949. Some of its important provisions are summarized below.

Scope and Definitions (Chapter I)

The Act extends to the whole of India except Jammu and Kashmir.

'Factory' means any premises including the precincts thereof:

- Wherein ten or more workers are working or were working on any day of the preceding twelve months and in any part of which manufacturing process is being carried on with the aid of power or is ordinarily so carried on, or.
- Wherein twenty or more workers are working, or were working on any day of the preceding twelve months, and in any part of which a manufacturing process is being carried on without the aid of power or is ordinarily so carried on.

Health (Chapter III)

Sections 11 to 20 deal with provision of environmental sanitation to promote and protect the health of the worker. Some provisions are given below.

CLEANLINESS (SECTION 11)

Every factory shall be kept clean and free from effluvia arising from any drain, privy, or other nuisance. Dirt and refuse must be removed daily from benches, stairs, floors, etc. Floors are to be cleaned by washing with disinfectant (when necessary), once a week. Painting and varnishing to be done once in 5 years (once in 3 years in case of washable water point).

DISPOSAL OF WASTES AND EFFLUENTS (SECTION 12)

Effective arrangements shall be made for disposal of wastes and effluents arising from manufacturing process.

VENTILATION AND TEMPERATURE (SECTION 13)

Adequate circulation of air is required at temperature convenient and not injurious to health. If work is in high temperature, hot parts should be insulated or cooled by other means.

DUST AND FUMES (SECTION 14)

If a manufacturing process emits dust or fumes or other impurities, injurious to health of worker adequate measures shall be taken to prevent their inhalation and accumulation. If exhaust appliance is necessary for this purpose, it shall be applied as near as possible to the point of origin of the dust or fume.

ARTIFICIAL HUMIDIFICATION (SECTION 15)

The State Government may prescribe standards of humidification. If humidity of air is artificially increased in a factory, the water used for the purpose shall be taken from a public supply or other source of drinking water, or shall be effectively purified before it is so used.

OVERCROWDING (SECTION 16)

Space for a factory worker shall be provided at the rate of 14.2 cubic meters per worker. Space 4.2 meters above the floor is ignored for this purpose.

LIGHTING (SECTION 17)

In every part of the factory, the management shall provide sufficient light—natural, artificial or both. Skylights be kept clean, and there should be no glare from source or from reflection.

DRINKING WATER (SECTION 18)

- It should be sufficient, wholesome and provided at convenient places
- All water points be marked 'Drinking Water' and not be situated within six meters of a washing place, latrine or urinal
- If more than 250 workers are employed, cool water to be provided in hot weather.

LATRINES AND URINALS (SECTION 19)

They should be sufficient, easily accessible, well lighted, kept clean by sweepers and separate for sexes of sanitary type with walls lined up to 90 cm by glazed tiles. The number of latrines and urinals according to Factory Rules, made in terms of the Factories Act should be as follows:

Latrine Accommodation (Rule 41)

1 latrine for 25 females; for males, 1 for 25 up to 100 and one for fifty thereafter.

Urinal Accommodation (Rule 45)

1 for 50 men, two feet apart, up to 500 men; after that one for 100 or part thereof.

Safety (Chapter IV)

Sections 21 to 40 and the rules under this chapter prescribe the precautions to be taken for safety against injuries and accidents which are likely to occur while at work in the factory. These include fencing of machinery, nonemployment of young persons on dangerous machines, protection of eyes by use of goggles, precautions against fire, dangerous fumes, etc. *Section 40-B* provides for appointment of a Safety Officer in factories employing 1000 workers or more.

Welfare (Chapter V)

The Sections under this chapter lay down specific welfare measures which promote health and provide medical care. Some provisions are as follows:

WASHING FACILITIES (SECTION 42)

Adequate and suitable facilities, separate for males and females, should be provided at convenient places.

FACILITIES FOR SITTING (SECTION 44)

This section provides that where the workers are obliged to work in standing position, suitable arrangements for sitting shall be provided in order that they may take advantage of any opportunities for rest which may occur in the course of their work.

FIRST AID APPLIANCES (SECTION 45)

First aid boxes or cupboards with prescribed contents, easily accessible, throughout the working hours be provided at the rate of 1 for every 150 workers employed of anyone time. Persons handling them should be trained and readily available any time. If more than 500 workers are employed, an ambulance room should be provided with medical and nursing staff and prescribed equipments.

CANTEENS (SECTION 46)

These shall be maintained by the employer if more than 250 workers are employed.

CRECHES (SECTION 48)

If more than 30 women are employed, suitable rooms shall be provided to keep children under 6 years. The accommodation should be adequate, lighted and ventilated. The creche should be kept under the charge of a woman trained in the care of infants and children. (Rules 80 to 83 of the Factories Rules made under Factories Act deal with refreshments, free milk, medicines, change of clothes, washing, bathing and furniture to be provided for the children and for the mothers who have to come and feed the babies at regular intervals).

WELFARE OFFICER (SECTION 49)

A welfare officer has to be appointed when the number of workers is 500 or more.

Working Hours for Adults (Chapter VI)**ADULT WEEKLY HOURS (SECTION 51)**

It provides: "No adult worker shall be required or allowed to work in a factory for more than 48 hours in a week."

WEEKLY HOLIDAYS (SECTION 52)

It provides a holiday for or one full day each week.

DAILY HOURS (SECTION 54)

Not more than 9 hours a day.

INTERVALS FOR REST (SECTION 55)

Not more than 5 hours work at a stretch followed by rest for at least half an hour.

WOMEN WORKERS (SECTION 66)

No women to be employed between the hours of 7 pm and 6 am.

Employment of Young Persons (Chapter VII)

Not to work in factory unless 14 years are completed (Section 67). No child to work for more than four and a half hours a day and not at night from 10 pm to 6 am (Section 71).

Annual Leave with Wages (Chapter VIII)

Leave with wage to be given at the rate of 1 for 20 days work to an adult and 1 for 15 days work to a child, if they have worked for 240 days or more during a calendar year. Adult woman shall be given maternity leave for 12 weeks, 6 weeks before and 6 weeks after delivery (Section 79).

Special Provisions (Chapter IX)

Certain accidents to be notified by the manager of the factory to the authorities specified (Section 88).

Also, if any worker in a factory contract a disease specified in the third schedule of the Act, the manager shall send notice therefore to the prescribed authorities. Some of the diseases are poisoning by lead, phosphorus, mercury, manganese, arsenic, carbon bisulphide, benzene, nitrous fumes, halogens or halogen derivatives; chrome ulceration, anthrax, silicosis, toxic anaemia, toxic jaundice; primary epitheliomatous cancer of the skin; or pathological manifestations due to radium or other radioactive substances or X-rays (Section 89).

The Employees State Insurance Act, 1948

Welfare of the common man is one of the objectives of the Constitution of India. An industrial worker is exposed to 'employment injury' which includes accidents and diseases related to his occupation. During illness or employment injury, a worker faces fear of economic, physical or even social ruin. Social insurance

or social security against this has to be provided by the employer and the state. Efforts in this direction began with the Workmen's Compensation Act of 1923 and the State Maternity Act which followed it. Passing of the ESI Act (1948) was the most important step towards social security. The act provides benefits in cash and kind in case of sickness, maternity and occupational injury and thus alleviates economic and physical suffering. The scheme was first started in February, 1952 in the industrial towns of Delhi and Kanpur and now it covers most of the industrial towns in the country. The ESI Act of 1948 was amended twice, once in 1975 and later again in 1984.

APPLICABILITY

The ESI Scheme extends to whole of India. The scope of the Act has been progressively increased. The 1948 Act covered factories using power and employing 20 persons or more (excluding mines, railways and defence services). The 1975 Amendment extended the Act to the following:

- Nonpower using factories employing 20 or more persons
- Powerusing factories employing 10 or more persons
- Road transport establishments
- Newspaper establishments
- Cinemas and theaters
- Hotels and restaurants
- Shops.

WAGE CEILING FOR COVERAGE

Wage ceiling for purpose of coverage is revised from time to time by the central government on the specific recommendation of the corporation. At present the employees drawing wages up to Rs.15,000/- per month (excluding remuneration for overtime) come under the purview of the ESI Act. An employee who is covered at the beginning of a contribution period shall continue to remain covered till the end of that contribution period notwithstanding the fact that his wages may exceed the prescribed wage ceiling at any time after the commencement of that contribution period. Health insurance scheme under ESI offer full medical care to workers and their dependents without any ceiling on expenditure.¹³

ADMINISTRATION

The ESI scheme is administered by an autonomous body called Employees State Insurance Corporation (ESIC) which meets at least twice a year. It is constituted as below under the ESI Act, 1948.

- Minister for Labor—Chairman
- Secretary, ministry of labor—Vice Chairman
- 5 representatives of Central Government
- One representative each from the States and one representatives of Union Territories

- 5 representatives of employees and 5 of employers, 2 of medical profession and 3 Members of Parliament.
- The Director General of the Corporation.
A *Standing Committee*, which meets 4 times in a year, is constituted from amongst the members of the Corporation. It has a strength of about 16, including the Director General of ESIC who acts as the chief executive for the Scheme.

Medical Benefit Council

It is an advisory body to ESIC. It consists of:

- Director General of Health Services;
- Deputy Director General of Health Services;
- Medical Commissioner of the ESIC;
- One member from each state, 3 representatives of employees, 3 of the employers and a few from the medical profession, of which one must be a woman.

The ESI Corporation is a policy making body, the Standing Committee is an executive body and the Medical Benefit Council is an advisory body to advise on organisation of medical relief.

Director General of ESI is the Chief Executive Officer, assisted by 4 Principal Officers: (1) Medical Commissioner, (2) Financial Adviser and Chief Accounts Officer, (3) Insurance Commissioner, (4) Actuary.

The Corporation, as per S.25 of the Act, appoints Regional Boards in the States, Local Committees and Regional and Local Medical Benefit Councils. It delegates them powers to administer the scheme in the States. It also appoints Inspectors to inspect factories regarding the benefits given to workers.

The ESI scheme is financed as follows:

FINANCE

The ESI scheme is a self-financing health insurance scheme. The scheme is primarily funded by contribution raised from insured employees and their employers as a small but specified percentage of wages payable to such employees. The covered employees contribute 1.75% of the wages, whereas as the employers contribute 4.75% of the wages, thus total 6.50% of the wages. Employers earning less than fifty rupees a day as daily wage are exempted from payment of their share of contribution. The state government as per the provision of the act bears *one-eight* share of expenditure on medical benefits within a per capita ceiling of Rs.1000 per insured person per annum.

BENEFITS

Benefit to employee: Various benefits under the act that the insured employees and their dependants are entitled are as follows:

- Medical benefit
- Sickness-benefits

- Maternity-benefits
- Disablement benefit
- Dependents benefit
- Funeral expenses
- Rehabilitation benefit
- Other benefits.

Medical benefit (in kinds): Insured employee and their dependants are entitled to free full medical benefit, which includes the comprehensive package of services like primary medical care, specialist and diagnostic services, in-patient care with provision for all super specialist facilities. The medical benefit also includes ambulance services, domiciliary treatment facility and provisions of drugs, dressings and some appliances. The primary care, out patient, in patient and specialist services are provided through a network of panel clinics, ESI dispensaries and hospitals, whereas the super specialty services are provided through a large number of advanced empanelled medical institutions on referral basis.

The medical care is delivered by following two systems:

1. *Direct system:* ESI hospitals and dispensaries directly deliver services. A dispensary with full time medical officer and paramedical staff serves an area having 1000 or more 'employees family units'; but part time ESI dispensaries are established to serve an area having less than 750 workers.
2. *Indirect system or Panel system:* In this system empanelled private medical practitioners called 'Insurance Medical Practitioner' provide care to the workers and their dependent family members.

Sickness-benefits: Sickness benefit is paid in cash to the insured persons to compensate their loss of wages in the event of sickness certified by an authorized medical officer. It is admissible for 91 days in a year and the cash benefit is equal to 50 percent of the wages.

Extended sickness benefit (cash): For some specified long-term diseases like paralytic disorders, tuberculosis, leprosy, coronary artery disease, psychosis, chronic pulmonary disease, malignancy, fracture, etc. (34 specified diseases) that need prolonged treatment and absence from work on medical advice are entitled for the cash benefit for longer period of two years. Amount payable in cash as extended sickness benefit is equal to about 70 percent of the daily wages.

Maternity benefits: Maternity benefit is payable to insured women in case of confinement or miscarriage or sickness related thereto. For confinement, the benefit is normally payable for 12 weeks, which can be further extended up to 16 weeks on medical grounds. The duration of benefit for miscarriage is 6 weeks. The rate of payment of the benefit is equal to wage.

Disablement benefit (in cash): Payable for temporary or permanent, partial or total disablement as a result

of employment injury (including occupational diseases). Benefit for temporary disablement is paid at the rate of about 72 percent of the wages for the duration of disablement. For permanent total disablement, the payment is made at the same rate for the whole life in the form of a pension and at proportional rate in case of permanent partial disablement.

Dependent benefit (in cash): It is payable to dependents of insured person dying as a result of employment injury. The payment is made according to the plan prescribed.

- Widow of the deceased gets the benefit throughout her life or until remarriage.
- Legitimate or adopted children are paid till 18 years of age, (or till marriage in case of a daughter getting married before 18 years).

Funeral expenses: On the death of an insured person a sum of a maximum Rs. 2,500 is payable to the family member to meet the funeral expense from local office.

Other benefits:

- *Free supply* of physical aids and appliances such as crutches, wheelchairs, spectacles and other such physical aids.
- *Preventive health cares* services such as immunization, family welfare services, HIV/AIDS detection, treatment etc.
- *Rijiv Gandhi Shramik Kalyan Yojana:* Under this scheme the insured person who are rendered unemployed involuntarily due to retrenchment / closure of factory is entitled for unemployment allowance for a maximum period of 6 months during entire services period provided along with medical benefit.
- *Rashtriya Swasthya Bhima Yojana (RSBY):* Under this scheme the ESI hospitals has been allowed to expand their scope of services by offering health cover to beneficiaries of the Rashtriya Swasthya Bhima Yojana (RSBY), which provides health insurance cover to people living below the poverty line.

Rehabilitation benefit: Workers entitled to receive an artificial limb are awarded a rehabilitation allowance, for each day of their admission at the artificial limb center, for provision or replacement of an artificial limb. The rate is equivalent to the sickness benefit rate.

Besides the Factories Act and ESI Act, there are several other Acts that have been framed to ensure worker's rights, safety, health and welfare. Some of these are listed below.

- Mines Act, 1952
- Plantations Labor Act, 1951
- Motor Transport Workers Act, 1961
- Shops and Commercial Establishment Acts (State Acts)

- Employment of Children Act, 1938
- Beedi and Cigar Workers (Conditions of Employment) Act, 1966
- Atomic Energy Act, 1973.

BENEFIT TO EMPLOYERS UNDER ESI ACT

- Compliance under the act brings about healthy work force and augmentation in production
- Discharge the employer from liability under other labor enactments such as Workmen's Compensation Act, Maternity Benefit Act, etc.
- Saves from the imposition of interest/damages/compensation/prosecution
- Employers get rebate under Income Tax Act on contribution to ESIC
- Exempted from liability of organizing health case services for employees

Worker Absenteeism

Absenteeism is a major factor affecting work productivity and is closely related to a worker's health as well as his personal, domestic and social life. In the 5 million strong work force of India working in the registered factories, absenteeism has been found to be as high as 15 to 20 percent. In individual terms, it signifies an absence rate of 8 to 10 days per head per year. The causes of absenteeism are:

- Sociocultural causes related to domestic and social factors such as joint family system, harvesting season, fairs and festivals, quarrels, etc.
- Personal factors such as age, sex, separation from family, alcoholism, addiction, indebtedness, personality not fitting the job, insufficient training, etc.
- Occupational environment including physical environment (machines, work room, etc.) and social environment (employer and coworkers, etc.)
- Natural illness such as malaria, respiratory diseases, tuberculosis.
- Occupational injury due to accidents and harmful agents in industry.

It should be apparent from the above that the first two causes are not directly related to disease or occupational hazard at all, while the third cause has only some relation to occupation as a cause of ill health. The last two causes alone are associated with absenteeism directly arising out of ill health. It is thus implicit, and amply borne out by facts, that only a small proportion of worker absenteeism is due to sickness. However, workers tend to avail of sickness benefits by claiming the same for situations that, in reality, are not related to sickness.

The solution to the problem of absenteeism lies in dealing with the cause after thorough investigation of the occupational environment of the workers.

Their unions, industrial health team, management, government, International Labour Organization (ILO) and Industrial Research Institutes, all have to play important role.

Some New Initiatives

ESIC PEHCHAN CARD¹⁴

Employees' State Insurance Corporation is issuing two hi-tech cards to all their workers. One for the insured person and another for his family members. Temporary or casual workers can also avail this facility.

Advantage of Pehchan Card

- Easy identification of insured person and family members.
- Whole family can avail ESIC's complete medical facilities anywhere, anytime with this card in any ESI dispensaries/hospitals across the country.
- This card is valid for life.
- Hassle free amendment of family member's description.
- In future, insured person's medical history to be available online, with every ESIC institution.

SKILL DEVELOPMENT INITIATIVE SCHEME (SDIS) BASED ON MODULAR EMPLOYABLE SKILLS (MES)¹⁵

Ministry of labor and Employment has launched a new scheme 'Skill Development Initiative' to train, test and certify skills of youth population in the country to increase employability, productivity to meet workforce requirement as well as to improve global competitiveness of industries. Focus has given on certification of skills recognized nationally and internationally.

Key Features

- To impart MES training and award certificates, reimbursement of training cost and assessment fees to successful trainees.
- Demand driven short term training courses based on Modular Employable Skills (MES) are decided in consultation with industry.
- Flexible delivery of training programs (part time, weekends, full time, onsite/offsite) to suit needs of various target groups.
- Courses are available for persons having completed 5th standard and attained 14 years of age.
- Persons with skills acquired through years of work but without any formal certificate can get their skills tested and certified.

INCENTIVE SCHEME FOR EMPLOYERS TO EMPLOY PERSONS WITH DISABILITIES¹⁶

Employers in the private sector, have a social responsibility to provide employment opportunities to persons with disability. The Government of India will bear the employer's share of provident Fund contribution on wages upto Rs. 25,000 per month for three years in case of employment of persons with specified disabilities appointed on or after 01.04.2008.

Advantages

Such disabled persons covered under ESI scheme shall be entitled to: medical benefit, sickness benefit, maternity benefit, disablement benefit, dependant's benefit, funeral expenses, rehabilitation allowance, vocational rehabilitation, old age medicare, medical bonus, unemployment allowance (Rajiv Gandhi Shramik Kalyan Yojana).

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Environment pollution may be described as the unfavorable alteration of our surroundings and occurs mainly because of the actions of man.¹ These actions are of two types—those relating to reproduction and those relating to industrialization. Population growth is really the most important cause of pollution. The world is overcrowded with people who consume resources and create wastes. As regards industrialization, the actions of man include excess energy consumption using the earth fuels (coal and oil), synthesis and use of various chemicals, and use of radioactive substances. It is in view of the above that the two general indicators of sources of pollution in various countries are the population density and the gross national product (GNP).¹

Well-known environmental tragedies, like the cases of mercury poisoning in Minamata (Japan), severe smoke pollution episodes in London and the massive oil spill caused by the Terrey Canyon accident reinforced in people's mind, the sense that the quality of air, water and a wide range of other natural resources was being seriously degraded.

Pollution can be studied under the following six headings:

1. Air pollution
2. Water pollution
3. Soil and land pollution
4. Radioactive pollution
5. Thermal pollution
6. Noise pollution.

Air Pollution

Air *pollutants* are the materials that exist in the air in such concentrations as to cause unwanted effects. *Air pollution* may be described as the imbalance in the quality of air so as to cause ill effects.¹ Air pollutants may be natural (e.g. smoke from forest fires or volcanoes) or man-made. We are concerned here mainly with the latter. These are of two types—gaseous and particulate.

Gaseous Pollutants

These are substances that are gaseous at normal temperature and pressure. Substances with boiling point below 200°C are also included in this category.¹ Gaseous pollu-

tants may be primary (those emitted into the atmosphere as such) or secondary (those produced by interaction of primary pollutants with the atmosphere). Of the five gaseous pollutants described below, the first four are primary while ozone is secondary. Hydrocarbons are also primary pollutants.

CARBON MONOXIDE

This is one of the most abundant air pollutants. Its major source is automobile exhaust. Hence, its concentration shows marked diurnal variation in urban areas.

SULFUR DIOXIDE

It is one of the principal air pollutants. It is produced by combustion of sulfur bearing fossil fuels and coal. It is also produced in certain industries where sulfur ore is roasted (copper, zinc, lead smelting industries), as also in oil refineries and industries producing fertilizers, paper, pulp and sulfuric acid. Sulfur dioxide is readily absorbed by soil, plants and water surfaces. It causes deterioration and corrosion of metal, cement, paints, leather, paper, textile, etc.

HYDROGEN SULFIDE AND ORGANIC SULFIDES

Sulfides are very foul smelling. They are produced in industries like paper, rayon, tar distillation, coke and natural gas refining. However, they do not cause much harm because effluents from these industries are usually adequately processed in purifiers. Municipal workers entering large sewers have died of hydrogen sulfide poisoning.

OXIDES OF NITROGEN

These are very abundant air pollutants, second only to carbon monoxide. Their chief source is automobile exhaust, the other source being chemical industries manufacturing nitric acid, sulfuric acid and nylon intermediates.

OZONE

It is a secondary pollutant. The chief culprit is automobile exhaust. The nitrogen oxides produced during petroleum combustion yield ozone in the presence of sunlight. Ozone and hydrocarbons undergo

photochemical reactions that produce aldehydes, ketones, organic acids, acylnitrates and peroxy compounds. These reactions particularly occur in the smog, which is a combination of smoke and fog. The sozone levels in atmosphere have not decreased in spite of substained efforts.

Particulate Pollutants

These comprise both solid and liquid particles varying in size from 0.1 to 20 microns. Smaller particles are present in aerosols. The particulate pollutants may be described as follows:

Dust

It consists of solid particles, usually 1 to 100 microns in size. Sometimes particle size may be as small as 0.1 micron.

Fumes

These are particles below one micron, generally formed from metals and metal oxides. Fumes are produced by condensation of vapor by distillation, sublimation, calcination and by other chemical processes.

Mist

These are liquid particles below 10 microns produced by condensation of vapor. An example is conversion of sulfur trioxide from gas to liquid (mist) form at 22°C.

Spray

These are liquid particles produced from parent liquid by mechanical disintegration processes, such as atomisation. The particle size varies from 10 to 1000 microns.

Smoke

It consists of solid and liquid particles 0.05 to 1 micron in size produced by incomplete combustion of carbonaceous materials. It may be mentioned that though incomplete combustion produces gaseous hydrocarbons and oxides of sulfur and nitrogen also, only the solid and liquid particles are termed as smoke.

Particulate contaminants comprise about 22 metallic elements, the most common of which are calcium, sodium, iron, aluminum and silicon. In addition, lead, zinc, copper manganese and magnesium are also present in significant amounts. An important source of lead in atmosphere is the vehicle exhaust because lead tetramethyl is added to petroleum as an antiknocking agent.

Source of Pollution

It is convenient to classify the sources of air pollution into four types.

STATIONARY COMBUSTION

An example is that of thermal power based upon combustion of coal or oil. It may be mentioned that the safest combustion is that of natural gas. This is because of the low particulate content and minimal sulfur content of natural gas.

Transportation

Example is fuel combustion in vehicular engines.

Industrial Processes

Cement and steel industries are particularly polluting.

Solid Waste Disposal

Burning of solid waste also causes air pollution.

Effects of Air Pollution

These will be described separately in relation to man, animals, plants, materials and the atmosphere.¹

EFFECTS ON MAN

The harmful effects of air pollution are most noticeable on the respiratory system.

Gaseous Pollutants

Carbon monoxide is well known to cause death through asphyxia related to methemoglobin formation. It may be mentioned that the affinity of carbon monoxide to hemoglobin is 240 times stronger than that of oxygen. *Sulfur dioxide* is a very serious pollutant. At lower levels, it causes bronchiolar smooth muscle spasm. At higher concentrations, it induces mucus production. Still higher concentrations cause desquamation of mucosal epithelium. The effect of sulfur dioxide is much greater in the presence of an inert aerosol, such as sodium chloride.¹ This gas is also toxic to eyes causing acute redness and irritation. In the atmosphere it reacts with other undesirable compounds to produce sulfuric acid droplets which, when inhaled, cause lung damage. Sulfur dioxide can also cause respiratory allergy. *Ozone* is a strong irritant. It can cause pulmonary edema and hemorrhage at very low concentrations. Among *oxides of nitrogen*, nitric oxide is non-irritant while nitrogen dioxide is a pulmonary irritant.

The main health problems caused by gaseous air pollutants are bronchitis, emphysema, asthma and lung cancer.

The relation between lung cancer and pollution can be explained by the following:

- Polluted air contains carcinogens such as hydrocarbons. Compounds extracted from polluted air have produced cancer in experimental animals.
- Lung cancer mortality rate is higher in urban areas.

- Pollutant irritation can reduce ciliary action of respiratory epithelium. However, it must be mentioned that there is still lack of absolute evidence that air pollution causes lung cancer.

Particulate Pollutants

The harmful effects of particulate matter depend upon particle size. Particles above five microns in diameter cannot penetrate respiratory mucosa. Particles of size one micron and less penetrate the alveoli easily. Soluble aerosols are directly absorbed into blood from the alveoli, while insoluble ones are carried in the lymphatic system. Important particulate pollutants include lead, beryllium, cobalt, asbestos, silica and some forms of carbon.

Some well-known air pollution episodes include those in Meuse valley, Belgium (1970, sixty deaths), Donora, Pennsylvania, USA (1948, seventeen deaths) and London (1952, four thousand deaths). In the Poza Rica episode in Mexico, hydrogen sulfide leaked from a refinery in 1952, killing 22 persons. The largest industrial air pollution episode occurred in India in 1984, where methyl isocyanate gas leakage caused 20,000 deaths in Bhopal.²

EFFECTS ON ANIMALS

These are by and large similar to effects on man. In addition, fluorosis can occur in animals when they consume forage contaminated with fluoride containing materials over a long time. This may result in lower fertility and milk production in animals.

EFFECTS ON PLANTS

Sulfur dioxide, fluorine compounds and smog are the three air pollutants of main agricultural concern. These cause reduction in photosynthesis and plant respiration. Sulfur dioxide can cause necrosis of leaf tissue. Short of necrosis, leaf damage can result in depigmented patches, a condition known as chlorosis. Cotton, wheat, barley and apple are particularly sensitive to sulfur dioxide injury. Fluoride damage is seen in many fruit trees.

EFFECTS ON MATERIALS

Smoke, grit, dust and oxides of sulfur are the main pollutants causing damage to materials. Sulfur dioxide is the worst pollutant because it gets converted to sulfurous and sulfuric acid in the presence of moisture and causes corrosion. Iron, aluminum, copper and their alloys are thus liable to be corroded. The damage caused is not serious, but is a big nuisance from an esthetic point of view.

EFFECTS ON ATMOSPHERE

Fossil fuel consumption increases the carbon dioxide concentration in air. Though CO₂ is not considered a

pollutant, it affects the atmosphere adversely. Carbon dioxide absorbs heat very effectively. As a result, cooling of earth by radiation is decreased and global warming may occur. It thus produces what is called a greenhouse effect (A green house is a glass house used in cold countries for plants. It has little or no artificial heating). Carbon dioxide, nitrous oxide and methane are called greenhouse gases. In atmosphere, these gases allow the sunlight in but trap the resultant heat, causing the greenhouse effect and global warming. During last one and a half centuries, after the advent of industrialization, the levels of carbon dioxide, nitrous oxide and methane have increased by 25 percent, 19 percent and 100 percent respectively. In addition, another class of synthetic chemicals, the chlorofluorocarbons (CFC) having a greenhouse effect have made their appearance during this period.³

It is estimated that a doubling of CO₂ on earth will result in an increase in its surface temperature by 1.3°C. Global average temperature are already 0.6°C higher compared to 100 years ago. During next 100 years, a further rise of 2.5 to 5.5°C is expected.³ A doubling of CO₂ content on earth will result in raising the temperature of earth's surface by 1.3°C.

Prevention and Control of Air Pollution

This is achieved in three ways:

1. *Proper selection and utilization of fuels:* Burning of coal produces more smoke while burning of oil produces more sulfur dioxide. Accordingly, a proper mix of fuel should be planned at the national level. Indian railways had planned earlier to substitute coal engines by diesel engines. This thinking is now being revised so as not to eliminate the use of coal altogether. At the international level most countries in the West are gradually encouraging the use of trains which had been minimized during the past few decades. This is aimed at decreasing the oil consumption by road vehicles.
2. *Change of equipment of processes:* An example is the electrostatic precipitator which is a very efficient device for preventing dust emission from fuel gases. It is used as a routine in large power stations. As regards control of gaseous pollutants it may be achieved by combustion, absorption or adsorption of the polluting gases. Combustion is applicable in the case of oxidisable gases produced in petrochemical, fertilizer and paint industries, but the cost is high. Absorption is achieved by transfer of gas molecules into a liquid phase through the use of spray chambers, etc. Adsorption has to be used when other methods are not applicable. This method needs the presence of large solid surface area. It is used for removal of toxic and foul smelling substances.
3. *Site selection:* This involves proper location of industrial plants away from places of habitation with due regard to meteorological conditions.

MOTOR VEHICLE EMISSION CONTROL

The main pollutants from motor vehicle exhaust are hydrocarbons, carbon monoxide and oxides of nitrogen. The hydrocarbons and oxides of nitrogen undergo further reactions in the presence of sunlight to produce secondary pollutants as described earlier. The techniques of controlling motor vehicle emissions include tuning, engine modification and catalytic reactors. As regards tuning, the concentration of carbon monoxide and hydrocarbons can be reduced by keeping a high air fuel ratio. Engine modification is aimed at more efficient burning of fuel. Catalytic reactors oxidise carbon monoxide to carbon dioxide while nitrogen oxides are converted to nitrogen.

Water Pollution

Water pollution refers to adverse changes in the composition or condition of water rendering it less suitable for use.¹ These changes may be physical, chemical or biological in nature.

Sources of Water Pollution

Three main sources of water pollution are industry, municipal sewage and agriculture. Industrial effluents are usually discharged directly into rivers, adding toxic chemicals to water that are harmful for health. *Industrial effluents* are also discharged into sewage system, sometimes at high temperature. The heat and the chemical compounds in the effluents adversely affect the biological purification mechanism of sewage treatment. The result is that the 'treated' sewage causes pollution when discharged into rivers. *Municipal sewage* is the second major source of water pollution. It contains decomposable organic matter and microorganisms, pathogenic as well as nonpathogenic. *Agricultural sources of water pollution* include insecticides, plant materials and fertilizers which are applied to crops and find their way into water systems.

Types of Water Pollutants

Water pollutants can be of two types.

PHYSICAL AND CHEMICAL POLLUTANTS

These include organic and inorganic contaminants. Mineral acids are present in discharges from chemical industries like battery manufacture, electroplating and DDT manufacture, etc. Organic acids are present in effluents of rayon, leather and dyeing industry as also distilleries. Soaps are present in soap manufacturing industry effluents as also in municipal sewage. Certain gaseous pollutants (ammonia, chlorine, hydrogen sulfide, ozone, phosphene) are also present in effluent of fertilizer, chemical and gas manufacture industries, etc.

as also paper and textile industry. Excess presence of free chlorine in river water destroys fish and other aquatic life, corrodes metals and can cause mucous membrane irritation and even pulmonary edema in humans.

Fertilizers are used nowadays at a large scale. Surplus fertilizers not taken up by the crops are washed over from land into rivers and lakes where the nitrates contained in them cause undesirable side effects. Similarly, farm waste can also pollute water. It may be mentioned that a cow and a pig produce sixteen and three times as much organic matter respectively as compared to man. This fecal matter largely consists of phosphate. The combined excess of nitrates and phosphates can cause nuisance over large stretches of water through *eutrophication*.

Sea water is contaminated through discharge of pollutants via rivers as also by oil spills from oil tankers. The oil film over sea surface prevents atmospheric oxygen from aerating and purifying the water. Large scale destruction of fish often accompanies large oil spills.

Synthetic detergents are now commonly used in homes and industries. They are usually nonbiodegradable, mainly because of the presence of alkyl benzene sulphonate. These compounds can produce foams at very low concentrations. The foaming action retards aeration of river water causing damage to aquatic flora and fauna.

BIOLOGICAL POLLUTANTS

These include primary and *corollary* pollutants. Primary pollutants are the ones directly attributed to man's activities, such as bacteria and viruses in sewage. Corollary pollutants are those, which are not directly attributable to human endeavor. Examples are weeds and algae. Bacteria and viruses may be pathogenic or nonpathogenic. The important pathogenic bacteria in water are *Salmonella*, *Shigella*, *Vibrio cholerae*, *Leptospira* and *Pasturella tularensis*. Among the viruses the most important ones are polio virus and hepatitis virus. It is important to remember that viruses are not attacked by combined chlorine (in the form of chloramines and other chlorine derivatives). However, free chlorine (in the form of hypochlorous acid or hypochlorite ion or both) can be active against them.⁴

Effects of Pollution on Quality of Water

The harmful effects of water pollution have been mentioned earlier. The changes in physical qualities of water are described below.

COLOR

Color itself is not harmful, but esthetic considerations render it unsuitable for human use. Color can occur

because of organic or inorganic substances. Organic dyes can impart color even in micro quantities. For example, magenta can impart red color at 0.02 ppm. Examples of inorganic substances are iron and chromium, which impart red color. Tannery waste discharged into streams with high iron content causes deep green or bluish color.

TURBIDITY

This is caused by colloidal particles, which do not settle down, and fine particles which remain suspended and settle down with difficulty. There is no sharp demarcation between the two. Water turbidity is an index of pollution. However, water may be clear, yet polluted with acids, toxic substances or bacteria. Iron and manganese in water can cause stains on clothes and sanitaryware.

FOAM

Foam is a suspension of air bubbles in water medium. The primary reason for foam in river water and sewage works is widespread use of syndets (synthetic detergents). Foaming tendency is more in relatively clean water and decreases as pollution increases. Even the final effluent from sewage treatment plants contains considerable amounts of syndet.

TASTE

Common industrial effluents imparting taste are iron, chlorine and phenols. Others are manganese, syndets, oils, petroleum products and hydrocarbons. Algae, fungi and some bacteria also impart musty taste.

ODOR

The main types of smells in water are putrid (due to hydrogen sulfide), fishy (due to organic amines), wormy (due to phosphorus compounds) and earthy (due to humus). Both odor and taste can be removed by aeration and active charcoal. Ozone and chlorination are also helpful.

Soil and Land Pollution

The problem of land pollution differs from air and water pollution in that the pollutants remain in place for long periods. With the increase in population and use of more and more land for buildings, the empty land is diminishing while the amount of pollutants is increasing. Land pollution is caused by solid and semisolid wastes arising from agricultural practices and insanitary habits.

Types of Soil Pollution

Soil pollution can be described under four groups as follows.¹

BY INDUSTRIAL AND URBAN WASTES

Industrial wastes arise mainly from coal and metal mines and the engineering and metal processing industries. Urban dry wastes include commercial and domestic wastes as also municipal waste in the form of dried sewage sludge. Approximately 50 percent raw material used in industry is ultimately discarded as waste, of which 15 percent is toxic or harmful. Most of the solid waste is disposed off by land tipping. Garbage dumps constitute breeding ground for vermin and insects. It is estimated that 70,000 flies can breed in one cubic foot garbage.

BY AGRICULTURAL PRACTICES

Such pollution is caused by the following.

Fertilizers

When artificial fertilizers are used in excessive quantities, these may be washed out into water system. This is especially true of nitrates. Sometimes, the chemical fertilizers are contaminated with other chemicals, which pollute the soil where fertilizers are applied.

Pesticides

These include chlorinated hydrocarbons and organophosphorus compounds, etc. These may find their way into crops, particularly root crops grown in soil. For example, lindane has been detected in carrots.

Other Soil Chemicals

These include soil conditioners and fumigants. Examples are mercury, arsenic and lead compounds. These stay in soil permanently and find their way into plant products.

Farming

Cattle farming and poultries produce large amount of waste. In this is not suitably disposed and is merely dumped as garbage, it causes nuisance of smell and sight in addition to public health problems.

BY RADIOACTIVE MATERIALS

The source of such pollution may be radioactive waste from nuclear laboratories and industries or atmospheric fall out from nuclear explosions. The latter is facilitated by rains. A large number of radioactive substances can pollute soil. Examples are strontium-90 and caesium-137. Both have half-life around 30 years.

BY BIOLOGICAL AGENTS

Bacteria and parasites in human and animal excreta contaminate the soil when hygienic excreta disposal

facilities are not available. Open defecation in the fields in rural and slum areas is the single most common source. Discharge of untreated or incompletely treated sewage on land and dumping of sewage sludge also cause soil pollution. The pollution, this, can cause be rather long lasting. *Ascaris* eggs and *Salmonella* organisms can survive on soil for 2 years and 70 days respectively.

In conclusion, one may say that soil pollution, sometimes referred to the third pollution (after air and water pollution), is certainly widespread and needs to be curbed. Solid wastes constitute the major cause of soil pollution. The remedy lies in promoting hygienic habits and use of biodegradable material.

Radioactive Pollution

Radioactive emissions are of three types, i.e. alpha, beta and gamma rays, consisting of particles carrying positive, negative and no charge respectively. The gamma rays are identical to X-rays. Radioactive pollution is *defined* as “Increase in natural background radiation emerging from the activities of man involving the use of radioactive materials, whether naturally occurring or artificially produced.” The naturally occurring radioactivity is of two types—cosmic radiation from outer space and terrestrial radiation from radioisotopes in earth’s crust. Cosmic radiation produces Carbon-14 and Hydrogen-3 which reach earth in the form of carbon dioxide and water. Naturally occurring radioactivity in the earth’s crust is found in the form of ores of uranium and thorium, potassium-40 and rubidium-87.

Environmental pollution occurs through the following activities.

- Processing of uranium and thorium ores
- Operation of nuclear reactors
- Testing of nuclear weapons
- Use of radiotracers in medicine, biology, agriculture and industry.

Radioactivity from the polluted environment may reach man directly or indirectly. Direct route includes exposure to radioactive gases and radioactive particles, X-rays, color TV sets, luminous dials of clocks and watches, etc. Indirect route includes consumption of radioactive particles through food chain. This may occur through ingestion of (i) plants that have acquired radioactivity from contaminated soil or water, (ii) animals that have fed on such plants, (iii) animals living in contaminated water, (iv) irradiated foods, and (v) contaminated water having radioactive particles.

Radioactive pollution is distinct from other types of pollution in that the effects are confined not only to the exposed persons but also to the future generations. This is so because of the genetic mutations caused by radiation. Other major harmful effect of radiation is malignancy, particularly leukemia. It may be mentioned that there is no threshold or safe dose for radiation. Even a small

increase above natural background radioactivity can place a person at risk. The maximum permissible doses of radiation as recommended by the International Commission on Radiation Protection (ICRP), are as follows:¹

Total lifetime dose: 200 rem. One rem (Roentgen equivalent man) is the amount of radiation that will produce an energy dissipation in man that is biologically equivalent to one roentgen of radiation of X-rays or approximately equals 1000 ergs/g. In turn, Roentgen (r) is a unit of X-ray or gamma-radiation intensity. It is the amount of radiation (gamma or X-ray) that produces one electrostatic unit of electricity in one cubic centimeter of dry air at normal temperature and pressure.

Weekly dose: The above lifetime dose amounts to 0.1 rem per week. The ICRP has recommended the limit of 0.3 rem per week for a radiation worker with the condition that the dose in any 13 weeks period should not exceed 13 rem.

Yearly dose: 5 rem.

It is important to clarify that rem is a unit of radiation energy while curie is a unit of radioactive disintegration. One picocurie (micro-micro curie) means 3.7×10^{-2} disintegrations per second. According to the Federal Radiation Council, drinking water should not have gross beta radiation above 1000 picocurie in the absence of alpha emitters and strontium-90.

PREVENTIVE MEASURES

Storage and Discharge of Radioactive Waste

- *Low activity wastes*—These can be discharged into sewers or streams. These should be stored for sometime before discharge so as to reduce activity.
- *High activity wastes*—These cannot be discharged as such. The radionuclides from such wastes are segregated by coagulation, precipitation, or ion exchange. The concentrated nuclide in solid form is stored or buried. Waste water remaining behind can be discharged.
- *Very strongly active wastes*—These cannot be treated and have to be stored indefinitely. These may be buried under the ground or may be stored in sea at a depth of 6000 feet in concrete filled stool drums. The latter is a cheaper method.

Limitation of Emission of Radioactive Pollutants

Appropriate techniques during handling of radioactive material can reduce the amount of emission. For example, such handling may be carried out under a jet of soil or water.

Dispersal

When emission can not be reduced, dispersal of pollutants over a large area dilutes the pollutant and

decreases the risk. Proper ventilation and use of high chimney help in dispersal.

Reduction of Individual Exposure

This can be achieved by:

- Reducing duration of exposure—The operation should be carried out as quickly as possible. More persons can be put on the job so that time taken is less. Workers can be rotated so that exposure per person is less;
- Maintaining safe distance from the source;
- Shielding by wearing lead apron, etc.

Thermal Pollution

The term thermal pollution is not wholly satisfactory because heat itself is not a pollutant. This term is used here to denote the impairment of the quality of environment through an increase in temperature of air or water. Thus, 80 percent of all water used in industry is utilized merely as a coolant. Nuclear power plants and thermal power stations are the major heat producers. Thermal loading of water systems adversely affects aquatic life as follows:

- As water temperature rises, dissolved oxygen decreases and, conversely, oxygen demand increases. The result is increase in anaerobic conditions and release of foul gases. Also, aquatic organisms die out because of lack of dissolved oxygen.
- Increase in water temperature makes the pathogenic organisms more virulent, causing large scale death of fish.
- Green algae grow at 30 to 35°C and blue green algae at 35 to 40°C. Thermal pollution of water promotes growth of blue green algae which is a poorer food source and may even be toxic to some fish.

Global Warming

The future of the planet and human mankind is at stake. Emission of greenhouse gases such as carbon dioxide from the burning of fossil fuel for industry, power and transport, and other human activities such as deforestation are warming the planet. Scientists believe an average global temperature rise higher than 2°C would lead to catastrophic climate changes. Sea level rise, crop losses from erratic weather, deaths, disease and even mass migrations as well as social upheavals are among the myriad predicted impacts. There is a difference between weather and climate. Weather consists of those meteorological events, such as rain, wind, and sunshine that can change day by day, even hour by hour. Climate is the average of all these events over a period of time, like a year or several years.

Global warming is the increase in the average temperature of near surface of Earth. During the last

100 years due to huge industry and automobiles the issue of global warming becomes an urgent and emergent crisis which merits immediate action. About two-third of solar energy reaching earth is absorbed by the surface of earth. Rest of the heat radiated back to atmosphere. Greenhouse gases like carbon dioxide traps the heat; this trapping is essential for making the planet inhabitable for human population. During the last 50 years, human activities affected global climate.⁵

DIFFERENT GREEN HOUSE GASES¹

Water vapor: One of the most abundant gases in the atmosphere and builds up with the evaporation from water bodies on the Earth.

Carbon dioxide (CO₂): It is produced by the combustion of fossil fuels and from forest fires.

Methane (CH₄): It is released from animal husbandry, irrigated agriculture and oil extraction.

Nitrous oxide (N₂O): It is a by-product of burning fossil fuels and is also released when ploughing farm soils.

Ozone (O₃): Ozone is both a natural and a man-made gas, it is the main protective layer in the upper atmosphere, which shields the Earth from the sun's harmful ultraviolet radiation. But when produced in excess due to smog and severe air pollution, it becomes harmful to human health.

Chlorofluorocarbons (CFCs): It causes depletion of the atmospheric ozone layer. This chlorine-containing gas used for refrigerators, air conditioners, etc.

The industrialized countries account for about 72 percent of total carbon dioxide emissions that have accumulated in the atmosphere between 1950 and 2005. Between 1980 and 2005 emissions from the US were double those of China and seven times the emissions of India. But China and India are large emitters. China's absolute emissions are the highest in the world, and India is the fifth highest emitter.

IMPLICATIONS

Climate has powerful impact on human civilization and any change in existing climate will threaten to erode human civilization.

Water stress and scarcity: Glacial melting poses a serious threat by reducing stored water supply; that would affect agriculture, environment and human settlement. There is also a threat of flood due to accelerated glacier melting.

Rising sea level: Sea level is also rising due to increased disintegration of ice sheets, so chance of flood in the coastal region.

Agriculture and food security: Climate change will affect rainfall, temperature and water availability for agriculture. Again, there will be expansion of draught

affected areas. Loss of agriculture will lead to poverty, unemployment, etc.

Ecosystem and biodiversity: Climate change will lead to rapid loss of coral, wetland and forest. Coral is the livestock of many marine fishes. Death of coral will cause extinction of marine species. Loss of wetland and forest will have a profound effect on human civilization by increased risk of floods, storms, cyclones and will endanger the live of polar animals. Average global temperature is expected to rise by 0.2 degrees Celsius per decade over the next 100 years.

Human health: Floods, cyclones will increase the risk of some communicable diseases like cholera, diarrhea, malaria etc. Extreme weather can lead to heat stroke or hypothermia. Undernutrition may become a problem due to scarcity of foods.

WHO has its slogan 'Protecting health from climate change' in the year 2008 to draw attention from all over the world.

'Kyoto protocol' emerged in December 1997, highlighted opportunities and difficulties in trying to achieve legally binding targets. The US never accepted this protocol, insisting that large emitters such as China and India should also contribute to the emission reduction process. The protocol set a five percent emissions reduction target for the industrialized countries during the first period of the protocol—up to 2012.

The 15th UN climate change conference opened in 'Copenhagen 2009' with 192 countries, which was expected to finalize strategies to reduce or limit emissions of earth-warming carbon dioxide and other greenhouse gases in the years beyond 2012 through different actions by lifestyle changes of people. Reducing emissions may be achieved through multiple clean energy initiatives. New energy efficient appliances may cost higher than low efficiency appliances. Consumers may have to bear the burden if the government does not subsidize such products. People may be coaxed to rely more on solar energy for lighting or heating water.

The trouble with Copenhagen is not a disagreement over the need for strong policy, as environmentalists seem to think. The problem is that the world cannot agree on how to cooperate. The roadblocks are costs and fairness. US Policy is also not helping.⁶ Over the last few years, in anticipation of Copenhagen's failure, a new approach, Flexible Global Carbon Pricing, has been developed. It preserves the central carbon-pricing goal of Kyoto, but encourages cooperation by changing the climate game.⁷

Noise Pollution⁵

Noise can be defined as unwanted sound. In other words, it is sound without agreeable musical quality.⁵ Sound travels in pressure waves. The "sound pressure" can be expressed in two ways—(i) frequency of sound waves, related to pitch of sound and, (ii) amplitude, related to loudness. Unit of frequency is cycles per second. Unit of loudness is decibel (dB).

Noise pollution has assumed alarming proportions. Common sources are industry, transport and public address systems. Listening to radio and TV at high volume for long hours, can also cause noise trauma.

Levels of Noise⁶

Normal conversation is carried on at about 60 decibel level. The Central Pollution Control Board of India has set the safe limit for ambient noise at 55 dB for residential areas and 65 dB for commercial areas. Zero decibel represents the threshold of hearing. Moderately loud noise covers 70 to 90 dB. Average and heavy city traffic noise corresponds to 70 and 90 dB respectively. Very loud noise spans 90 to 110 dB. Examples of 100 and 110 dB respectively are a farm tractor and a jet plane flying 310 meter overhead. Uncomfortably loud noise occurs at 110 to 120 dB, the latter level occurring in discotheques. Noise at 120 to 140 dB can be labelled as painfully loud. For example, a 50 horse power siren 30 meters away can produce a noise level of 140 dB.⁵

NOISE TRAUMA AND ITS PREVENTION⁷

This has already been discussed in Chapter 9 (Occupational health).

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Biological environment is intimately related to infective disease and its components can act a reservoir, (e.g. cattle, rodents and man), vector (e.g. mosquito, ticks) and agents of infection (e.g. bacteria). The biological environment consists of plants and animals. The discussion in this chapter will be limited to the latter, with a major focus on medical entomology. However, this does not mean that the components of vegetable kingdom are not important for human health. Thus bacteria and fungi are responsible for several diseases while the food eaten may impair health if it is deficient, excessive or toxic. Examples of food toxicity are mushroom poisoning, ergot poisoning and lathyrism. These aspects are discussed elsewhere in this book.

Animals constituting the biological environment may be divided into vertebrates and invertebrates. Among vertebrates, birds, especially parrots, can transmit psittacosis and ornithosis while fish may be responsible for allergy and fish tapeworm infection. Among invertebrates, protozoa, helminths and arthropods are well known as agents and vectors of infection. In this chapter, attention will be focussed on rodents and arthropods along with the methods for destroying them as they play a very vital role in epidemiology of many important communicable diseases. Rodents will be described first, followed by arthropods. In the end, control of insects will be described.

Rodents

Rodents include rats, mice, and some field rodents such as Bandicoots, *Gunomys kok*, marmots, *Tatera indica*, etc. In Mumbai, some of the rodents like Bandicoots

and *Gunomys kok* have become domesticated and susceptible to plague because the erstwhile field areas have become inhabited.

DAMAGE DONE BY RATS

Rats are voracious eaters. One rat consumes its own weight of food per month. Rats eat 1/5th of the food grown by the farmer. Besides, they damage common household articles. Rats serve as reservoirs of infection also. Bandicoots and other field rodents can exchange plague infection with domestic rodents. Thus, they may serve as reservoirs of infection and maintain the disease in interepidemic periods. *Tatera indica* has been found to be a natural reservoir of plague. Various diseases transmitted by rodents are listed in **Table 11.1**.

The magnitude of damage that rats can cause is evident from an interesting incident in 1938. Thousands of rats burrowed tunnels under the Mohul Bhim airport, 100 miles from Karachi in undivided India. The ground yielded to the slightest pressure and no plane could land safely. Rat trapping, poisoning and gassing were all ineffective. The airport had ultimately to be abandoned.

Common rodents that live close to man are:

- *Rattus rattus*, the gray or black domestic rat that lives in inland districts.
- *Rattus norvegicus*, the brown rat that lives mostly in seaport towns.
- *Mus. musculus*, the ubiquitous mouse.

Rats are larger than mice. **Figure 11.1** shows the difference between the two types of rats. The lower diagram shows the difference between a mouse and a young rat.

TABLE 11.1: Diseases transmitted by rodents

Disease	Reservoir	Mode of transmission to man
<ul style="list-style-type: none"> • Plague and murine typhus • Salmonellosis 	Rats and, to a much lesser extent, <i>Mus. musculus</i> <i>Mus. musculus</i> and rats	Through rat fleas Contamination of foodstuffs by droppings and possibly through rat fleas
<ul style="list-style-type: none"> • Leptospiral jaundice (Weill's disease) 	Rats (especially Norwegian rats)	Contamination of food and water by urine of infected animals
<ul style="list-style-type: none"> • Rat bite fever • Trichinosis (Trichinellosis) 	Rats and, probably, <i>Mus. musculus</i> Rats	Bite by an infected rodent By eating infested pigment
<ul style="list-style-type: none"> • Rickettsialpox 	<i>Mus. musculus</i>	Through a mouse bite (<i>Allodermanyssus sanguineus</i>)
<ul style="list-style-type: none"> • Lymphocytic choriomeningitis 	Mice, hamsters	A virus infection, possibly through direct contact or airborne spread

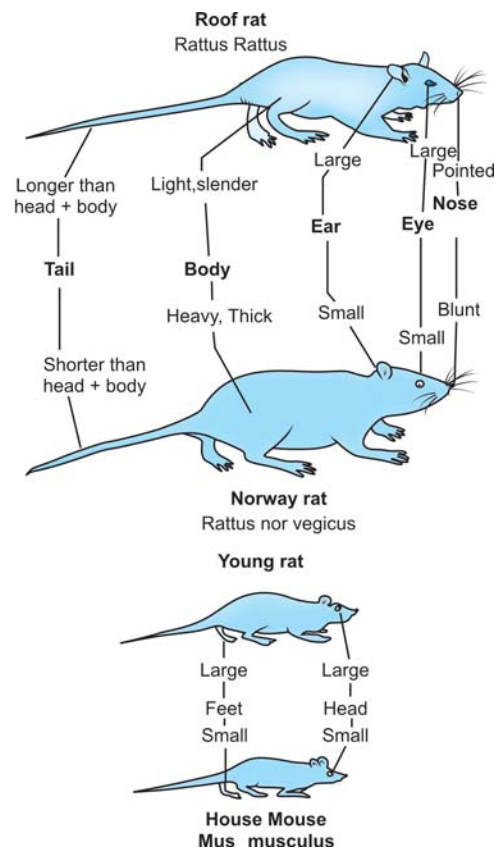


Fig. 11.1: Common rodents. "The upper portion compares the two types of rats. The lower portion compares a mouse and a young rat"

HABITS

Normally nocturnal; during the day the rats remain in their nests near the food. There is seasonal migration of fields. They run along the walls and narrow passages and move long distances. Mice move in the range of 3 to 7.5 meters and are not shy of new environments.

Rats can cut through hard surfaces including concrete. They can pass through holes bigger than 1.25 cm. Burrow size is usually not more than 45 cm. Norway rat is a good swimmer but the other two types cannot swim. Some comparative characteristics of the three species are given in **Table 11.2**.

Mouse is very small as compared to the rat. Differentiation is needed only between the sewer rat and house rat (**Fig. 11.1**). The former has a larger body, proportionately shorter tail, ears and eyes and a blunt muzzle or nose (which is pointed in the house rat).

RAT CONTROL

It should be in the form of an all out mass campaign rather than piecemeal efforts. Assessment of infestation should be made by special surveys by counting the dropping, runs, fresh knowings and rat burrows. This is also done by weighing of plain baits and an estimate is made on the basis of consumption of flour at 10 g per rat per day. Infestation is considered to be light if the number is 20 rats per house, medium if 21 to 50 and heavy if over 50. Two main methods of control are elimination and destruction.

Rat Elimination

- All food should be kept covered, or placed in wire-net cupboards. The garbage tins should have well fitting covers. Food grains and flour should be stored in metal containers.
- Gutters should be trapped and windows closed at night to prevent entry of rats.
- All existing rat burrows should be closed.
- Floors, roofs and walls of the house should be pucca and should not provide hiding or breeding places.
- Household articles should be arranged in such a way that no hiding places are created.
- Food grain godowns should be so constructed that:
 - The floor of the godown is raised one metre above the ground level
 - No staircase connects the ground to the floor at the gate of the godown
 - A one metre wide ledge protrudes out from the floor in front of the gate and
 - Roof should be a slopping one and should protrude out one meter from the walls.

TABLE 11.2: Comparative characteristics of sewer rat, house rat and domestic mouse

S. No.	Characteristic	<i>R. norvegicus</i> (Sewer rat)	<i>R. rattus</i> (House rat)	<i>M. musculus</i> (Domestic mouse)
1.	Color	Gray or brown but may be black	Black, gray, brown, may have white belly	Brown or gray
2.	Body	Large and heavy wt 275-500 g	Slender and slim. Wt 115-350 g, usually up to 225 g	Small, wt less than 30 g
3.	Length of head and body	18-22.5 cm	16-20.5 cm	6.5-9 cm
4.	Tail	Smaller than head and body combined	Longer than head and body combined	Varies
5.	Ears	Small	Large, cover eyes when folded	Small
6.	Food	Eats fresh food, garbage and other wastes	Nibbles anything, can eat 11 g rice per day	Prefers grain and fresh food
7.	Droppings	In groups	Scattered, sausage shaped	Scattered, fine spindles
8.	Habitat	Seaports, ships, sewers	Inland houses	Allover
9.	Swimming	Swims well	Cannot swim	Cannot swim

Rat Destruction

Trapping: The spring trap or break-back trap is used by placing it at right angles to the runs. It catches one rat at a time. The wonder trap developed by the Haffkine Institute, Mumbai is in the form of an elongated cage which is claimed to catch as many as 25 rats at a time. It is placed parallel to burrows. Baits used are flour, chillies, or other staple food of the area. After some time, the rats, but not mice, become trap-wise, i.e. cautious. In such a case, camouflage by covering the traps with gunny bags or torn pieces of paper may be useful. Traps should not be oiled as oil repels the rats. The trapped rodents should be killed by drowning.

Keeping predators: The cats are good to kill mice but not rats. Terrier dogs are good at catching rats.

Fumigation or gassing: This can be done in case of ships and heavily infected houses. Calcium cyanide (cyano gas) is used for this purpose.

Calcium cyanide is insufflated into burrows to kill the rats there. The burrows are then closed. Rooms can also be insufflated through after closing and sealing the doors and windows or hole in the doors or walls. The gas kills not only the rats but also fleas and other vermin.

Poison baiting: This is done with the use of rodenticides which are mixed with rat bait. There are two types of rodenticides depending upon whether they have to be used only once or repeatedly. Single dose or acute rodenticides are listed in **Table 11.3**. Multiple dose or cumulative rodenticides have to be given for three days or more. They are anticoagulants that cause internal hemorrhage and slow death over a period of 4 to 10 days. Their continued use led to development of resistant strains of Norway rat in some countries. In view of this, as also the need for multiple doses and the potential toxicity to man, the use of cumulative rodenticides is not common and is not recommended. Examples are warfarin, coumafuryl, bromadiol, pindone and diphacinone.¹

The common rodenticides used in India are barium carbonate and zinc phosphide. *Barium carbonate* occurs

as a white powder and is cheap and nontoxic to man. It is mixed with flour in a proportion of 1 in 3 or 4 and small balls weighing about 150 mg are prepared and placed near rat burrows and runs. It is a weak rodenticide and kills the rats in 2 to 24 hours. As such, it is no longer the rodenticide of choice.² *Zinc phosphide* is the rodenticide now recommended for wide use.³ It is a black powder with the characteristic garlic smell of phosphine which is liberated when the powder is moist. Thus this substance is easily detected, thereby decreasing the chance of accidental poisoning. It is an efficient rodenticide, killing rats within three hours. One part of zinc phosphide is mixed with 10 parts of rice or wheat flour. A few drops of oil are added to provide flavour and attraction for the rats. Rubber gloves should be preferably used while handling zinc phosphide.

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Arthropods

MEDICAL ENTOMOLOGY

Entomology is a branch of zoology that deals with the study of insects. Insects form nearly 3/5th of the arthropods. They do man good as well as harm. They transmit diseases like malaria, filaria, yellow fever, typhus, relapsing fever, sleeping sickness, etc. By this, they have influenced history, affected the progress of mankind and decimated populations from time to time. The word insect is often used in a wider sense to include other arthropods, especially Arachnida. In this wider sense the term medical entomology is applied to all arthropods of medical importance.

The *phylum Arthropoda* is divided into many classes. Only three of these—Insecta, Arachnida and Crustacea—contain arthropods of medical importance. A fourth class, Chilopoda, consists of worm like creatures such as centipedes, which may bite man and inject poisonous substances leading to local and general symptoms.

Insects (also called hexapods) are broadly divided into winged and nonwinged groups. *Winged insects* have four developmental stages—egg, larva, pupa, adult. They are divided into 24 orders including Diptera (mosquitoes, flies, butterflies) and Siphonaptera (insects with laterally compressed bodies that have lost wings during the course of evolution because they have become whole time parasites. Fleas belong to this order). *Nonwinged insects* have three stages in the life cycle—egg, nymph (which is sexually immature) and adult. Examples of nonwinged insects are roaches

TABLE 11.3: Acute (single dose) rodenticides

- *Those requiring ordinary care:*
 - Zinc phosphide
 - Red squill
 - Norbormide
- *Those requiring maximal precaution:*
 - Strychnine
 - Fluoroacetamide
 - Sodium fluoroacetate
- *Those too dangerous to be used:*
 - ANTU (Alpha-naphthylthiourea)
 - Thallium sulphate
 - Phosphorus
 - Arsenic trioxide
 - Gophacide

(Order Orthoptera), bugs (Order Hemiptera, with dorsoventrally flattened bodies) and lice and white ants (Order Anoplura with bodies flattened dorsoventrally). It may be mentioned that the bugs belonging to order Hemiptera are true bugs, as against red bugs or chiggers which are in fact six legged larvae of Trombiculoid mites.

Arachnids (octopods) have four pairs of legs and no antenna. Three orders of class *Arachnida* are of medical importance. These are Scorpionida (scorpions), Arachnida (spiders) and Acarina (ticks and mites).*

Crustaceans (decapods) have five pairs of legs. These primitive arthropods bear a shell or crust, hence the name. The head and thorax form a single cephalothorax. The abdomen is long. They use legs on land and gills in water. They are divided into two subclasses. Those in subclass Eucepoda are small in size (e.g. cyclops). Those in subclass Decapoda are large in size (e.g. prawn, lobsters, crabs, shrimps and crayfish, the last being an intermediate host for *Paragonimus westermani*, the lung fluke).

The distinctive features of the three major cases of arthropods are summarized in **Table 11.4**. The arthropods of medical importance are listed in **Table 11.5**. Those described in this chapter are mosquitoes, flies, fleas, lice, bugs, scorpions, ticks, mites and cyclops, in that order.

Transmission of Diseases

The modes of transmission of arthropod related diseases are as follows.

Direct contact from man to man: For example, scabies, pediculosis.

Mechanical transmission: For example, transmission by housefly of microorganisms causing diarrhea, dysentery, typhoid, conjunctivitis, furunculosis, etc.

Biological transmission: In this mode, the causative agent of disease either multiplies in the arthropod host or undergoes some developmental change within it. According, there are three types of biological transmission.

1. When the agent multiplies within the arthropod, without any cyclical change (*Propagative type*). An example is the multiplication of plague bacilli within the flea.
2. When the agent does not multiply but merely undergoes a cyclical change within the body of the arthropod (*Cyclodevelopmental type*). Examples are the guinea-worm embryo in cyclops and filarial parasite in culex mosquito.
3. When the agent multiplies as well as undergoes cyclical change within the arthropod (*Cyclopropagative*). The well known example is the malarial parasite within the anopheles mosquito.

Certain terms commonly used in medical entomology in relation to transmission of diseases are defined below.

Vector: It is an invertebrate, whether arthropod or not, that transmits infection either by depositing the infective material on skin, mucous membranes food or other objects or by inoculating (through biting) the infective material into or through skin and mucous membranes.

Definitive host: The host in which the sexual cycle of the causative agent takes place (e.g. mosquito in malaria).

Intermediate host: The host in which the asexual cycle of the causative agent takes place (e.g. cyclops in guineaworm disease and mosquito in filaria).

Extrinsic incubation period: The period of time needed by the causative agent for development within the arthropod host. For example, the malarial and filarial parasites have an extrinsic incubation period of 10 to 14 days within the mosquito.

Infestation: This refers to the lodging development and reproduction of arthropods on the surface of the host's body or in the clothing.

Mosquitoes

Mosquitoes are the most important arthropods from the point of view of public health, being responsible for more morbidity and mortality than any other arthropod

TABLE 11.4: Features of arthropods

	Class <i>insecta</i>	Class <i>arachnida</i>	Class <i>crustacea</i>
Major type	Mosquitoes, flies, lice, fleas, bugs, roaches	Ticks, mites	Cyclops
Habitat	Terrestrial	Terrestrial	Aquatic
Body parts	Three: head, thorax, abdomen	Two: cephalothorax, abdomen	Two: cephalothorax abdomen
Wings	1-2 pairs, sometimes none	None	None
Legs	3 pairs	4 pairs	5 pairs
Antennae	1 pair	None	2 pairs

*The characteristic feature of order Acarina is that the head and abdomen are all fused into a single sac. The ticks (Family Ixodidae) are large and macroscopic. They possess few small hair and have an exposed hypostome with teeth. The mites are small and microscopic. They possess plenty of long hair and their hypostome is hidden.

listed in **Table 11.4**. They will hence be described in some detail.

LIFE CYCLE

It consists of four stages—Egg, larva, pupa and adult.

1. **Egg:** About one mm each in size, the eggs are laid on the surface of water, 100 to 300 at a time, about 12 times in the life span of a female mosquito. The male dies soon after mating. The female lives for 1-2 months. The eggs hatch into larvae in three to four days (**Fig. 11.2**).
2. **Larva:** It rests and breathes near the surface of water and wriggles about rapidly with darting movements. It grows into pupa in about one week.
3. **Pupa:** It has a large head and a ventrally covered body, which give it the appearance of an exaggerated comma. It has a pair of breathing trumpets on the thorax. It develops into an adult in about three days. During this period, it does not take any food and moults more than once. The total life cycle is completed in two to three weeks.

4. **Adult:** The male, smaller and more slender than the female, is vegetarian and spends most of its time in vegetation by the side of water. As a result, it is seldom seen in houses. It is differentiated from the female by the very hairy character of the antennae. The female is aggressive and larger. It sucks the blood of an animal (zoophilous) or man (anthrophilous), this blood sucking being essential for laying eggs. The palps have three segments and are tufted. These are used as feelers or organs of touch while the antennae are used to judge the air current. The female may travel up to 3 km but usually only up to 1.5 km. It sucks more blood when temperature and humidity are high and the skin is moist.

Four genera of mosquitoes—*Anopheles*, *Mansonia*, *Culex* and *Aedes*—are important from the point of view of disease transmission. The first of these belongs to subfamily Anophelinae and the rest to subfamily Culicinae. The differences between the two are shown in **Figure 11.3** and **Table 11.6**.

Mosquitoes of the genus *Mansonia* are biologically different from others. They lay eggs in clusters on the undersurface of water plants such as water lettuce, *Pistia stratiotes* and water hyacinth. Larvae and pupae remain

TABLE 11.5: Arthropods of medical importance	
Arthropods	Disease transmitted
Mosquitoes	Malaria, filaria, yellow fever, dengue, Japanese encephalitis
Houseflies	Diarrhea, dysentery, gastroenteritis, cholera, typhoid, paratyphoid, amebiasis, conjunctivitis, trachoma, helminthic infections, yaws, polio, anthrax
Sandfly	Leishmaniasis
Tsetse fly	Trypanosomiasis
Black fly	Onchocerciasis
Louse	Epidemic typhus, relapsing fever, trench fever
Rat flea	Plague, endemic typhus, <i>Hymenolepis diminuta</i>
Reduviid bug	Chagas' disease
Cockroach	Intestinal pathogens
Hard tick	Tick typhus, viral encephalitis, KFD, tularemia, tick paralysis, babesiosis
Soft tick	Q fever, relapsing fever
Trombiculid mite	Scrub typhus, rickettsial pox, scabies
Cyclops	Guinea worm, fish tapeworm

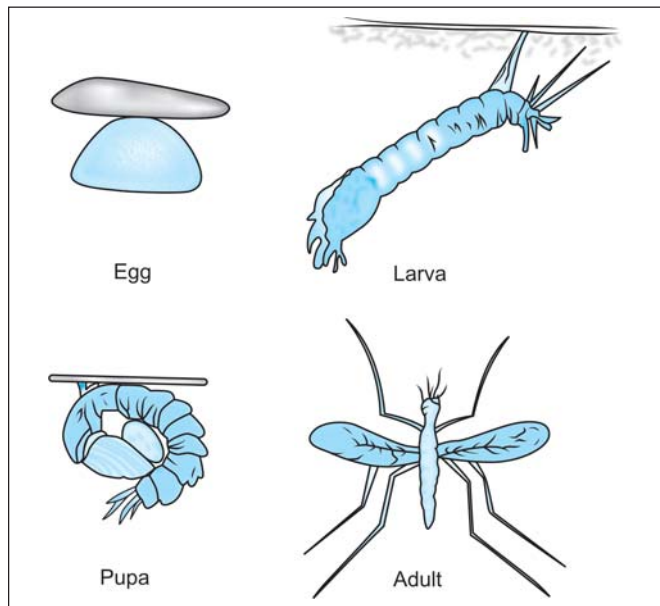


Fig. 11.2: Life cycle of mosquito

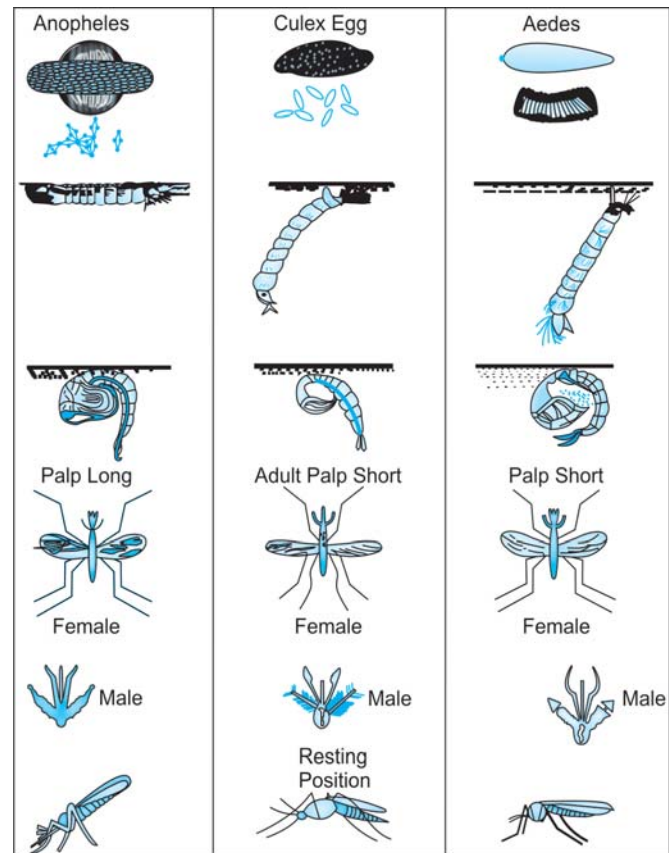


Fig. 11.3: Characteristics of *Anopheles*, *Aedes* and *Culex*

TABLE 11.6: Distinguishing characters of Anophelini and Culicini

	<i>Anophelini (Anopheles)</i>	<i>Culicini (Culex, Aedes and Mansonia)</i>
Eggs	a. Laid singly on water b. Boat shaped with lateral air floats	a. Laid in clusters or rafts of 100-250 (singly in case of Aedes) b. Oval with no air floats
Larvae	a. Siphon tubes absent b. Lie parallel to water surface c. Have palmate hair on abdominal segments	a. Two siphon tubes present b. Hang at an angle c. No palmate hair
Pupae	a. Siphon tubes broad and short	a. Siphon tubes long, thin and narrow
Adults	a. Sit against the wall at an angle so that proboscis, head and body form a line b. Quiet c. Wings are spotted d. Palpi long in male as well as female	a. Sit parallel to wall, the head and body are angled or hunch backed b. Make ringing noise in the ear (Aedes is quiet) c. No spots d. Palpi shorten in female

attached to the rootlets. They have a long siphon tube with a spine with which they pierce the plant and draw the air required, never coming to the surface. The adults, when mature, come out from below the surface of water. They have speckled wings and legs. The palps in the female are 1/4th of the proboscis in length. The important Indian species are—*M. annulifera*, *M. uniformis*, *M. longipalpis* and *M. indiana* (**Fig. 11.3**). They are mostly found in rural areas.

Forty-six species of *Anopheles* have been found in India. Only the following seven of these are vectors for malarial parasite:

1. *A. stephensi*
2. *A. culicifacies*
3. *A. fluviatilis*
4. *A. philippinensis*
5. *A. sundaicus*
6. *A. minimus*
7. *A. leucosphyrus*.

Of the above species, *A. stephensi* is found mainly in towns. *A. culicifacies* and *A. fluviatilis* are mainly rural, the former with indoor and the latter with outdoor resting habits.

The important *Aedes* (*Stegomyia*) species are *A. aegypti*, *A. vittatus* and *A. albopictus*. These are mainly found in the rainy season and are sometimes called tiger mosquitoes because of the stripes on their legs. Among the *Culex* (the common nuisance mosquito), the most important species is *C. fatigans*.

DISEASES TRANSMITTED BY MOSQUITOES IN INDIA

- *Anopheles*: They transmit malaria.
- *Culex*: They transmit Bancroftian filariasis (*W. bancrofti*), Japanese encephalitis and West Nile fever.
- *Mansonia*: They transmit Brugian or Malayan filariasis (caused by *B. malayi*) and Chikungunya fever.
- *Aedes*: They transmit viruses of dengue and chikungunya fever in India. Yellow fever, not found in India, is also transmitted by *Aedes*.

Mosquitoes also transmit disease from animal to animal such as monkey malaria and avian (bird) malaria.

METHODS OF CONTROL

Integrated Vector Management (IVM)

Ideally, malaria vector control activities should be part of a broader vector control management program. IVM entails the use of a range of biological, chemical and physical interventions of proven efficacy, separately or in combination, in order to implement cost-effective control and reduce reliance on any single intervention. Combinations of a number of methods will compensate for the deficiencies of each individual method. It includes safe use of insecticides and management of insecticide resistance. Rotation of insecticides may be done so as to prolong their effectiveness. It is based on the premise that effective vector control is not the sole preserve responsibility of the health sector but requires the collaboration of various public and private agencies and community participation.

Antilarval Measures

- *Elimination of breeding places (Source Reduction)*: It includes permanent measures such as—
 - Filling of low lying places where water may accumulate. This is particularly important for controlling breeding of *Anopheles*.
 - Weekly emptying of household collections of water, particularly to prevent breeding of *Aedes*.
 - Covering drains, ditches, cess pools and sewers near the houses, where *Culex* breeds.
 - Removal of vegetation on shores of slow moving streams where *A. fluviatilis* breeds.
 - Removal of water plants such as *Pistia stratiotes* and water hyacinth, manually or by herbicides, checks the breeding of *Mansonia*.
- *Larvicidals*: The breeding of mosquitoes can be reduced by a variety of physical, chemical and biological methods. Residual effect of larvicides varies considerably with the water quality. The higher dosages are indicated for polluted water. Larvivorous fish are widely used in urban areas, peri-urban areas and freshwater bodies in rural areas. Following methods are being used to control larval stage.

- *Mineral oils*: Kerosene, diesel, fuel oil and malariol are used for this purpose. These oils form a thin layer over water, thereby cutting off the oxygen supply to larvae and pupae. They also have probably a direct toxic effect on them. Larvae die within 1-2 hours of application of crude oil. The quantity of oil needed is 40 to 90 liter per hectare (one hectare = 10,000 sq m).
 - *Paris green* (copper acetoarsenite): It is used to kill surface feeding anopheline larvae. It is dusted at the rate of 840 g/ha (one hectare = 100000 sq m) of surface. There are no hazards to human beings and livestock at this concentration. Paris green is sprayed over water as dust. This dusting is not effective against culex larvae which are bottom feeders. However, special granular preparations of Paris green are available which are effective against these also.¹
 - *Synthetic insecticides*: The most effective larvicides are organophosphorus compounds like chlorpyrifos, fenthion and Abate, which quickly hydrolyse in water.² Abate is the least toxic of these and is very effective at a concentration of 1 ppm. Organochlorine compounds like DDT and HCH are no longer used as larvicides because of the associated effects like water contamination and emergence of resistant vector strains.
 - *Biological control*: Following methods are in use as vector control measures—
 - Larvivorous fish have been successful and widely used biological control agent against mosquito larvae in the top water. Two fish namely *Gambusia affinis* and *Poecilia reticulata*, (common guppy) have been extensively used for mosquito control in the urban malaria scheme in India under the National Anti Malaria Program. *Gambusia* is a surface feeder, hence it is suitable for feeding on both anophelines and culicines
 - Use of biocides: The bacterium *Bacillus thuringiensis israelensis* (Bti) and *B. sphaericus* produce toxins which are very effective in killing mosquito and blackfly larvae after ingestion. The toxins formulation may be used in water or for the irrigation of food crops to control vector.
 - *Insect growth regulators (IGRs)*. These are chemical compounds that are highly toxic to mosquito larvae by preventing their development into adults. Their use has generally been limited due to high cost and poor operational acceptability, but may be useful where other compounds cannot be used.
1. *Space spray*: Space spraying has been defined as the destruction of flying mosquitoes by contact with insecticides in the air. Unless applied during the night, when most malaria vectors are active, it may not be effective. Space spraying has very limited indications for malaria control because operational costs are high, the residual effect is low, requires special and expensive equipment, and its efficacy is often very dependent on the meteorological conditions at the time of application. The commonly used insecticides are pyrethrum, malathion and fenitrothion. The latter two are sprayed by ULV (Ultra low volume) fogging using specially designed apparatus.³ Pyrethrum may be used in the form of fog or mist through special equipment. Pyrethrum is a plant product (flower *Chrysanthemum cineraria* grown in Shimla and Kashmir). Active ingredient is 1 percent Pyrethrins and cinerins from extract of flower.
 2. *Indoors residual spraying (IRS)*: IRS is the application of insecticides to the inner surfaces of dwellings, where endophilic anopheline mosquitoes often rest after taking a blood meal. The main purpose of IRS is to reduce the survival of malaria vector(s) entering houses. The selection of an insecticide for IRS in a given area is based on data on insecticide resistance, the residual efficacy of insecticide, costs, safety and the type of surface to be sprayed. DDT has comparatively long residual efficacy (6 months or more) against malaria vectors and plays an important role in the management of vector resistance. With the development of resistance to DDT in many parts of the world the reliance on insecticidal approach continued with the introduction of replacement insecticides such as HCH/ Dieldrin, Malathion, Pirimiphos methyl, Fenitrothion, Carbamates (propoxure and bandiocarb) and synthetic pyrethroids, etc. WHO recommends DDT only for indoor residual spraying. Generally, all the interior walls and ceilings of permanent human dwellings should be sprayed. Two rounds of sprays are done for DDT and synthetic pyrethroids to provide protection during the entire transmission season. Three rounds are required in case of Malathion since the insecticide is effective for a shorter period only **Table 11.7**.

TABLE 11.7: Insecticides suitable as residual spray against malaria vectors

Toxicant	Dosage in g/m ²	Average duration of effectiveness (months)
DDT	1 or 2	6 to 12
Dieldrin	0.5	6 to 12
Lindane	0.5	3
Malathion	2	3
OMS-33 (Propoxur)	2	3

Antiadult Measures

Killing: The mosquitoes are killed in two ways by contact poisons:

Current policy of insecticide use in India: DDT should be the insecticide of choice for residual spray where it is sensitive. If resistance is noted with DDT then Malathion is the alternative choice; in case of resistance to DDT and Malathion both then synthetic pyrethroids is the choice. The use of HCH was banned in India in 1997 due to environmental concerns and partly due to resistance.

For *Mansonia*, in addition to insecticides, herbicides have to be used to destroy the weeds whose roots support the larvae.

The various types of formulations used for sprays are described later under the section Insecticides.

Genetic Control^{4,5}

Males sterilized by gamma irradiation and chemosterilants are released. They mate with females but the later produce unfertilized eggs which do not develop further. This is a potentially useful method that has yet to be tried on a large scale.

Prevention of Mosquito Bites

- *Use of repellents:* Diethyl toluamide (deet) and butyl ethyl propanediol applied on clothes repels *Culex* for 6-13 hours. Others in use are DMP, indalone, dimethyl carbate and ethyl hexanediol. They are applied to the exposed parts of the body.
- *Preventing entry into houses:* Mosquito-proof wire gauze (6 mesh) is used for this purpose on doors, windows and ventilators.
- *Sleeping in mosquito nets:* (6 mesh) and using veils, socks and gloves, etc. as necessary.

In regard to wire gauze and mosquito nets, it should be ensured that the number of holes should be at least about 25 per sq cm (i.e. 5 holes or 5 mesh per cm). It is preferable to use a net with 6 mesh per cm (15 mesh per inch).

Flies

Though less important than mosquitoes as vectors of disease, the flies have a large variety of species. They may be divided into two groups, the biting and nonbiting flies. The biting flies include sandfly, tsetse fly, blackfly and deer fly. Of these the sandfly is the most important. The common example of a nonbiting fly is the domestic fly.

SANDFLIES

They belong to order Diptera, family Psychodidae and subfamily Phlebotominae. The proboscis of sandflies is like a blade and not like a stylet as in case of mosquitoes. Minute in size (1.5-3 mm), they have lot of hair on the wings and body. The wings are hard and

stand out erect, forming a V. Flights are short and jerky as they are too weak to fly against wind (**Fig. 11.4**).

The sandflies breed in cracks in the walls and in stone heaps where there is enough nitrogenous waste. They sting at night and the bite is painful. Itching persists for sometime. Out of about 39 species of sandflies found in India, those of medical importance are *Phlebotomus argentipes*, *P. papatasii*, *P. sergenti* and *Sergentomyia punjabensis*.

Diseases Transmitted

The sandflies are responsible for the transmission of kala-azar (*P. argentipes*), oriental sore (*P. papatasii* and *P. sergenti*) and sandfly fever (*P. papatasii* and *P. punjabensis*).

Control

- Breeding is prevented by filling cracks and cervices on the walls and removing any stone or rock piles.
- The adults are killed by indoor residual spray insecticides like DDT and lindane in concentrations of 1-2 and 0.25 g per square metre respectively.
- Repellents used on clothes or applied to skin such as deet, DMP, etc. are effective against bites.

TSETSE FLIES

They belong to family glossinae and are limited to equatorial Africa. They are brown in color and have the same size as a house fly. Both male and female bite man and suck blood. They attack domestic animals as well.

Two species transmit trypanosomiasis:

1. *Glossina palpalis*—It transmits *Trypanosoma gambiense* and lives along water courses (hence called wet fly).
2. *Glossina morsitans*—It transmits *T. rhodesiense* and is sometimes called dry fly.



Fig. 11.4: Phlebotomus

Control

Insecticides used are organophosphorus compounds, DDT and dieldrin.

BLACK FLY

They are of the size of a mosquito. They breed in running water and are found in Africa. They transmit onchocerciasis.

DEER FLY

Deer flies belong to the genus *Chrysops*. They are yellowish in color and about one centimeter in length. Their wings have dark and pale areas. The bite is painful. They transmit loiasis, tuaremia and anthrax and are found in Africa, USA and USSR.

Housefly

Houseflies belong to the family Muscidae. Their mouth parts are adapted not to pierce the skin but to suck liquids and small particles. They are also called filth flies because of their filthy habits. They are one of the most widely distributed insects. The common species is *Musca domestica*. Other important species found in India are *M. vicina*, *M. nebulosa* and *M. sorbens*.

Life Cycle (Fig. 11.5)

It is completed in 4 stages—egg, larva, pupa and adult, and takes 10 to 14 days.

1. **Eggs:** They are laid five to six times in life, in batches of 100 to 200 on excreta and other soft, moist and warm filthy matter, especially horse litter. Glistening white in color and about one millimeter in size, the eggs, look like tiny grains of polished rice when seen with the help of a hand lens.
2. **M Larvae (Maggots):** Eggs hatch into larvae in 8 to 24 hours. They feed on organic matter. Actively

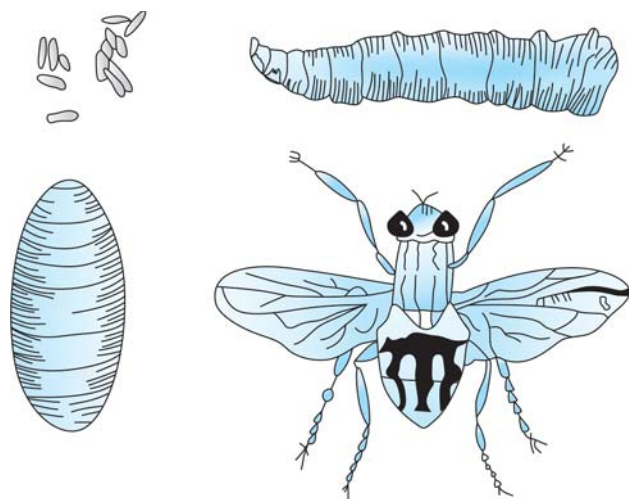


Fig. 11.5: Developmental stages of the housefly

motile, white, legless, 1.2 cm in length, with a distinct head, they grow rapidly and burrow into the food. They shun sunlight and come out at night. They migrate to dry earth to form pupae in three to five days.

3. **Pupa (Chrysalis):** It is barrel shaped and about six millimeter in length. It is initially pale yellow in color, changes to red brown and finally turns black. It represents a resting phase in the life cycle.
4. **Adults:** The adult fly emerges from the pupa in about a week. Mating starts a few days later.

Habits

The housefly is a restless insect, moving continually between food and filth. Its feeding habits are favorable to transmission of pathogens present in the excreta. An adult fly sucks, regurgitates, mixes, sucks again and vomits out the liquid food. It tends to move towards light and prefers to sit on strings and wires. It has a remarkable ability to locate food. Infection is carried by mechanical transmission (along legs, wings, body) and by deposition of vomit and feces on food and drink.

Diseases Transmitted

The housefly can potentially transmit a large number of diseases, e.g. typhoid, paratyphoid, cholera, diarrhea dysentery, food poisoning, polio, impetigo, anthrax, trachoma, etc. Maggots may invade human tissues and produce gastrointestinal, genitourinary or cutaneous myiasis, depending upon the mode of infection with the eggs.

Fly Control Measures

Elimination of breeding places:

- Sanitary disposal of wastes such as refuse (especially garbage), horse litter and dung, human excreta and sullage water.
- Food sanitation such as keeping all foods in wire gauze or glass cupboards and containers with well fitting lids.
- Tight packing of manure in trenches or pits to kill larvae by heat.
- Provision of cement lined tanks or floors for stocking cowdung so that larvae cannot burrow in the soil to pupate.

Prevention of entry: Making the houses flyproof, especially the kitchen and latrines, by putting wire gauze screens in doors and windows.

Trapping: Using a Balfour fly trap made of wire gauze in which the flies enter through a slit to sit on the bait but cannot come out.

Manual killing: Fly swatters are useful devices to kill flies.

Baiting: Baits may be used in houses, food establishments, cattle sheds, etc. Examples are:

- **Adhesive fly paper:** 500 g castor oil and 800 g resin are heated together and the mixture is spread on thick paper. Flies get stuck when they sit on the paper.
- **Tangle-foot paper:** Glue 1 part in 3 parts of water is spread on a paper which is placed in an arched position.
- **Strings and branches of trees:** They may be dipped in sugar or jaggery solution containing a toxicant such as formalin, sodium arsenite or organophosphorus compounds. The flies are attracted and get killed.
- Diazinon, dichlorvos, malathion, ronnel, naled, dimethoate and trichlorion may be used in dry or liquid baits. Sugar is used most often as a carrier. Liquid baits consist of 0.1 to 0.2 percent of toxicant and 10 percent of sugar or other sweetening agent in water. Commercial preparations are also available.

Insecticide spray: Pyrethrum may be used for space spray. Houseflies have become resistant to residual spray with almost all insecticides—chlorinated hydrocarbons as well as organophosphorus and carbonate pesticides. For susceptible species diazinon 1 to 2 percent, malathion 5 percent, dimethoate 1.0 to 2.5 percent and ronnel 1.5 percent are effective. 2 percent lindane, 5 percent methoxychlor and 5 percent toxaphene may also be tried at the rate of 4 liters per 100 sqm of surface. It may be mentioned that larvicidal spraying at breeding sites of housefly is not recommended. The reason is that this leads to development of insecticide resistance.

Health education of individuals, families and the community is essential for effective control.

Fleas

They belong to the order Siphonaptera and have laterally flattened body but no wings. Thus they differ from lice and bugs which are compressed dorsoventrally. They feed on a number of hosts such as rodents, cats, dogs, etc. Important fleas are those that migrate from the animal hosts to attack man. These are listed below:

***Pulex irritans* or human flea:** It is cosmopolitan in habitat. It causes dermatitis and may transmit human plague and endemic typhus. It is characterized by an ocular bristle below the eye.

***Xenopsylla cheopis*, *X. astia* and *X. braziliensis*:** These are oriental rat fleas responsible for transmitting plague and endemic typhus. They are characterized by an ocular bristle in front of the eye.

***Nosopsyllus fasciatus*:** This is the rat or squirrel flea of temperate regions. It has got a prenatal comb only.

***Ctenocephalus canis* and *felis*:** These are the dog and cat fleas. They possess pronotal and genal combs.

***Tunga penetrans* or sandflea:** It is found in the tropical parts of America and Africa. It is not found in India. It has an angular head.

Flea indices⁶ are helpful in indicating the potential for epidemic spread of plague in and around areas where this disease is endemic. Various indices have been described. The *general flea index* refers to the average number of fleas of all species present per rodent. The *specific flea index* similarly pertains to particular species of fleas.

Life Cycle (Fig. 11.6)

It includes egg, larval, pupal and adult stages.

Eggs: They are glistening white, about 0.5 mm in size. They are laid in batches of 8 to 12 in the debris in the cracks of floors, under carpets and in burrows, especially where there are food grains and dry earth. They hatch in two to four days in summer and in about a week in winter.

Larva: It is a white, active, legless maggot with scanty hair on the segments of the body. It lives in dust and feeds on the debris and feces of the adults. Its head is brown in color.

Pupa: It is concealed in a cocoon spined by the larva. It is seen in dirty and deserted places and can remain dormant for months. The adult usually comes out within a week.

Adults: After emerging, they get onto the hosts as wingless insects. Both male and female are blood suckers and the beak is provided with a siphon tube for this purpose. Head and thorax are united at the back. The legs have spines. The foot has five joints, the last of which has a hook as an adaptation for jumping.

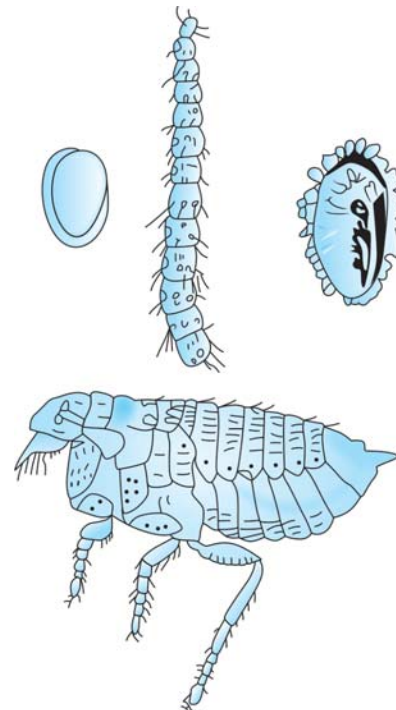


Fig. 11.6: Developmental stages of a flea

Diseases Transmitted

Bubonic plague, endemic typhus and *Hymenolepis diminuta* infection.

Control Measures

- Rats, mice and other hosts should be killed and other antirodent measures adopted.
- Dogs and cats should be dusted with 10 percent DDT or BHC powder.
- For plague control the floor, walls (up to one meter height) and rat-runs should be sprayed with organochlorines such as DDT, gammexane and dieldrin. Other insecticides such as diazinon, malathion and carbaryl are used in resistant cases.
- Burrows and rat-runs should be insufflated with 10 percent DDT powder or cyanogas. The latter kills both rats and fleas. Diazinon 1 to 2 percent and malathion 5 percent may be dusted where fleas have become resistant to DDT or BHC. Resistance to DDT, BHC and dieldrin is reported at some places in India where spray was done repeatedly for malaria control. Malarial spray has resulted in plague control also as a collateral benefit because of the killing of fleas.
- Flea bite should be prevented by use of repellents applied to clothing. Deet (diethyl toluamide) and benzyl benzoate are best for this purpose. Others, such as DMP, may be applied on skin.
- Contact with hosts, especially field rodents, should be avoided to prevent sylvatic plague.

Lice

These are blood sucking insects with a dorsoventrally flattened body and clawed legs. Both sexes live on the host itself. The following three species infest man (**Fig. 11.7**):

1. *Pediculus capitis* (Head louse)
2. *Pediculus corporis* (Body louse)
3. *Phthirus pubis* (Crab or pubic louse).

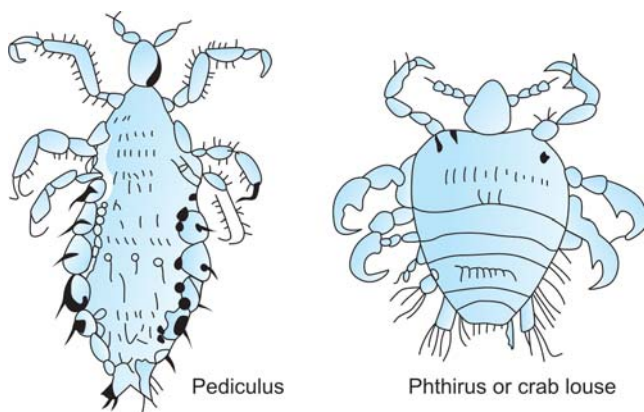


Fig. 11.7: Human lice

Life Cycle

It is in 3 stages—egg, nymph and adults.

1. **Egg:** The eggs (**Fig. 11.8**) are operculated with ovoid shape and white color. They are often known as 'nits'. The head louse lays 3 eggs a day and glues them to the hair. The body louse lays about 6 eggs a day and sticks them onto clothes, especially in the seams and linings. The crab louse lays 2 eggs a day and cements them to pubic hair.
2. **Nymph or larva:** The eggs hatch in about a week into nymphs or larvae which resemble the adults. These moult 3 times and turn into adults in another week.
3. **Adults:** Gray in color and 2 to 3 mm long, they have a life span of one month. They can live for a week without feeding. Head and body lice look alike and interbreed. The head is conical, joined with the thorax by a constriction. It bears a blood sucking proboscis and two antennae. The head louse is darker, smaller and brisker than the body louse. The crab louse is 1 to 2 mm long and has a squarish shape. It has a blunt, truncated head and strong legs, hence the name. It is found in pubic and perineal hair.

Louse bites cause irritation and sometimes, urticaria. Prolonged infestation may result in deep pigmented skin or melanoderma.

Diseases Transmitted

- *P. corporis* and *P. capitis* transmit *Rickettsia prowazeki*, the causative agent of *epidemic typhus*, and *quintana*, the causative agent of *trench fever*. The infection is transmitted through bite and feces. The crab louse is not known to transmit any disease.
- The head and body lice also transmit *Borrelia recurrentis* which causes *relapsing fever*. The organisms enter the body when infected louse is crushed on the skin.
- *Dermatitis* may occur due to scratching and secondary infection.

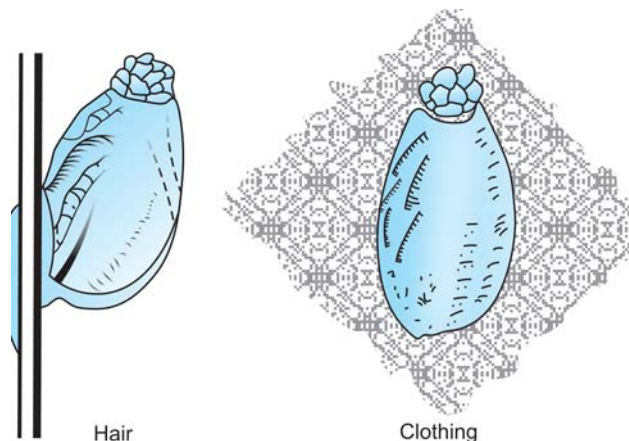


Fig. 11.8: Eggs of lice

Control Measures

Prevention of Infection

- Contact with infested person, often a servant or a fellow school child, should be avoided. Hat, cap, comb, hair brush and clothes of an infested person should not be used.
- The bedlinen and under clothes should be properly washed and the hair combed as a part of personal hygiene. If necessary, clothing may be dusted with carbaryl powder in highly lousy surroundings.

Delousing Measures

Applying 2 percent DDT emulsion or dusting with 10 percent DDT were very effective previously. With the emergence of DDT resistance, 0.2 percent lindane in coconut oil should preferably be used. In case of resistance to this also, 0.5 percent malathion lotion (1% in case of body louse) is effective. The lotion should be allowed to act for 12 to 24 hours before the hair is washed. It kills both lice and nits. Carbaryl dust may also be used as louse powder.³ An emulsion designated NBIN (68 percent benzyl benzoate, 6 percent DDT, 12 percent benzocaine and 14 percent Tween-80) applied after 1:5 dilution in water is also effective against lice as well as nits.⁷ Leather, wool and silk may be deloused by soaking them in 2 percent cresol and 50 percent soap emulsion for one hour.

Bugs

The common bedbugs (*Cimex lectularius* and *C. hemipterus*) are not known to transmit any disease. The Reduviid bugs are known transmitters of Chagas disease in South and Central America. Several species of these bugs are known to transmit *Trypanosoma cruzi*, the causative agent. Though Reduviid bugs have been described in India,⁸ they do not act as vectors of infection.

The bedbugs (**Fig. 11.9**) are nocturnal in habit and reside in the clothing and seams of linen. They emit a stinking odor. Their bite is very painful. They feed on blood, the feeding lasting for about 15 minutes. They can fast for up to six months.

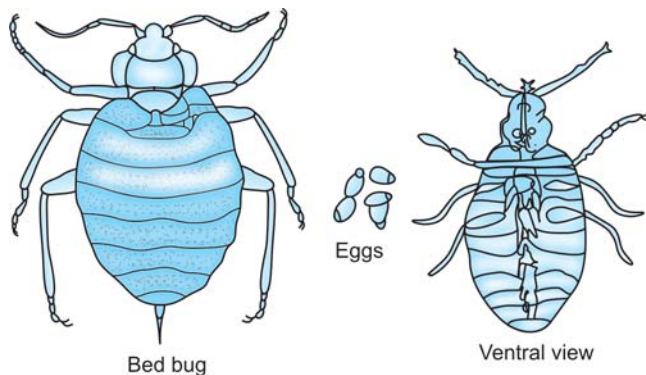


Fig. 11.9: Bedbug

Control

Bugs have become resistant to organochlorine insecticides like DDT, gammexane and dieldrin. Diazinon in kerosene oil is most effective but toxic. Other organophosphorus insecticides and carbamates are effective. Malathion resistance has also been reported.⁴ Synergised pyrethrum spray (with piperonyl butoxide, sesame oil and lindane) is effective against bedbugs.

Scorpions

These octapods belonging to class Arachnida do not transmit any disease. Their medical importance is limited to scorpion bite which is painful and may sometimes be poisonous. The bite of poisonous varieties of scorpions may produce severe systemic reactions such as lymphadenitis, twitching of muscles, spasm and convulsions. Patients may die of respiratory failure with pulmonary edema within two to three hours of the sting. The venom is probably a neurotoxin which acts peripherally.

Treatment for Scorpionism

A tourniquet is applied above the bite to prevent systemic spread of the poison. The wound is incised and the poison is sucked. Pain is relieved usually by a drop of strong or dilute ammonia solution poured directly. If necessary, 0.3 to 0.6 ml of 2 percent novocaine solution with epinephrine is injected near the puncture wound to combat pain. If systemic dissemination occurs, (indicated by profuse sweating, salivation, vomiting, myoclonic twitching or abdominal pain), specific antivenom should be given. Cortisone may have to be administered.

Control

Sprays with 2 percent chlordane, 10 percent DDT and 0.2 percent pyrethrum in kerosene are useful to kill scorpions. Dieldrin, BHC and organophosphorus compounds are also effective as surface spray or dust.

Ticks

Ticks are blood sucking parasites. Their natural hosts are domestic animals such as cats, dogs and cattle. They attack man only accidentally. The two families of medical importance are Ixodidae (hard ticks) and Argasidae (soft ticks, **Fig. 11.10**). The hard ticks remain attached to the host while the soft ticks leave the host after feeding.

LIFE CYCLE

It consists of four stages (egg, larva, nymph and adult) and is completed in two years (**Fig. 11.11**).

1. **Eggs:** They are laid on the ground in batches of thousands and take 2 weeks to one month for hatching.

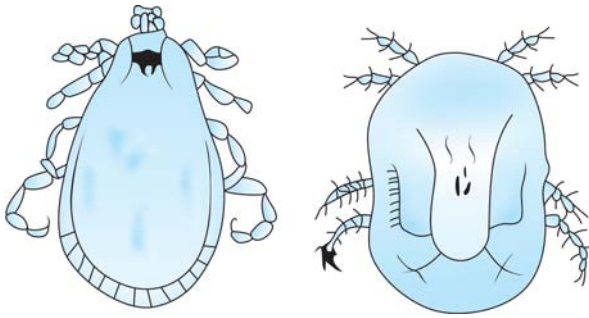


Fig. 11.10: Hard and soft ticks

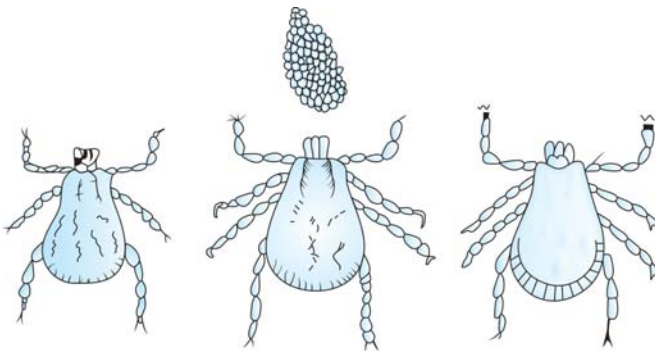


Fig. 11.11: Life cycle of tick

2. **Larvae:** Smaller than adults, they have only 3 pairs of legs. They jump about to feed on small rodents, then leave them, shed skin and develop into nymphs.
3. **Nymphs:** They are octapods like adults adults are sexually immature. They remain unfed for about a year. Later on they feed on rodent or man, then fall to ground and change into adults.
4. **Adults:** They hibernate for one year before sucking blood of larger animals or man.

DISEASES TRANSMITTED

Hard ticks: Tick typhus (Rocky mountain spotted fever), Q fever, viral encephalitis, viral hemorrhagic fevers (e.g. KFD) and tularemia. They transmit babesiosis in animals and may also sometimes cause human babesiosis. In addition, they also cause tick paralysis.

Soft ticks: They mainly transmit relapsing fever.

CONTROL MEASURES

Dimethyl phthalate (DMP) is a good tick repellent, especially against larvae. Clothes dipped in 5 percent DMP and 2 percent soap solution retain the repellent effect for one to two months. Infested animals may be dusted with lindane, malathion or DDT.

Mites

Mites are parasitic to man and animals and produce irritation of skin (acariasis). The mites of public health importance are the itch mite and the trombiculid mite.

ITCH MITE (*SARCOPTES SCABIEI*)

The scab or itch mite is the causative agent for scabies. It is found all over the world. Infestation is more common when living is congested.

All the four stages of the parasite (egg, larva, nymph and adult) are completed in the skin, the development from egg to the adult occurring in about two weeks. The female makes zig-zag burrows and lays eggs deep in the horny layers of the skin. Eggs develop into three legged larvae, which enter hair follicles and grow into nymphs and adult. The adult is 0.4 mm in length and oval in shape with flat ventral and convex dorsal surface. The spines and bristles on its body given it the appearance of a hedgehog (**Fig. 11.12**).

The male dies after mating, leaving behind the fertilized female to cause the disease. Places of predilection for burrows are: interdigital webs, wrists, elbows, feet, penis, scrotum, buttocks and armpits. Face, palms and soles are always free in adults but may be involved in children. The scabies mite can be located in the skin with the help of the hand lens.

Clinical picture appears after sensitisation of the skin over a period of a month or two. This can be called the incubation period. To start with, erythematous patches are seen around the burrows. These develop into papules and vesicles. Itching is intense at night, which leads to scratching and secondary infection. Personal contact of prolonged nature, such as sharing the same bed, is needed for infection. However, transmission through bedlinen is not likely as mites prefer the warm body. Off the host, the parasite dies within two days.

Prevention and Control

- Direct contact with the infested person, or indirect through undergarments, should be avoided. Proper personal hygiene should be observed including bath with soap and water.

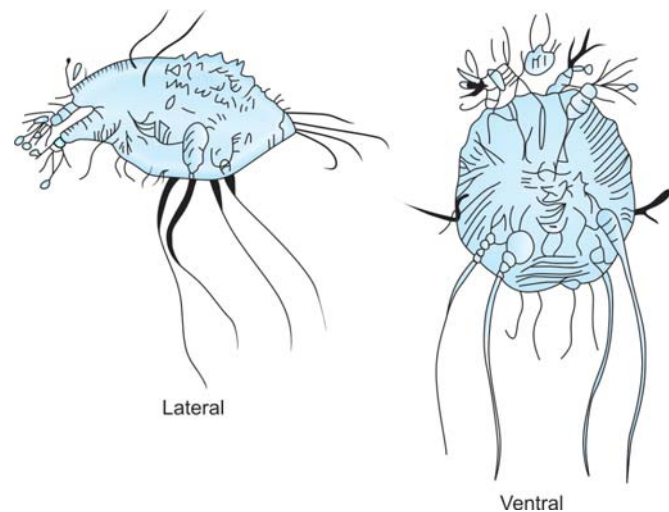


Fig. 11.12: *Sarcptes scabiei*

- The infested persons and contacts should be treated thoroughly with 3 to 5 percent sulfur ointment or 20 to 25 percent benzyl benzoate emulsion. The patient should take hot bath with soap and water, scrub the affected parts with brush, dry the body with rough towel, and rub the medicine all over, especially over the affected parts. He should then put on clean clothes and take no bath for 48 hours. The old clothes should be sterilised by boiling. Second application may be necessary.
- Tetmosol 5 to 10 percent in soap is a good prophylactic. Five percent tetmosol solution is a good sarcopticides and can be applied three times a day.
- 0.5 to 1 percent BHC or Gamma HCH (lindane) in coconut oil is a good sarcopticide when applied on the affected part two or three times at interval of two to three days.

TROMBICULID MITE (REDBUGS OR CHIGGERS)

Redbugs (**Fig. 11.13**) are the six legged larvae of mites belonging to family Trombiculidae. They alone are parasitic to man while the adults or nymphs live in the soil. The parasitic larvae are called redbugs, chiggers, harvest mites or scrub mites. *Leptotrombidium akamushi* is found in Japan and *L. deliens* in India. Their larvae are called red bugs because of their brick red color.

L. akamushi larvae, when anchored to the skin, inject saliva that produces irritation and causes tissue reaction. They transmit *Rickettsia orientalis*, the causative organism of scrub typhus, or tsutsugamushi fever. The transmission is transovarial—the larva bites and becomes infected and passes on the infection to nymph and adult stages. The female transmits the infection to the ovum from which the larva emerges and bites the fresh host, thereby passing on the infection.

Prevention

Use of repellents protects against larval bites when sitting on infected grass. Such repellents may be used on the exposed parts (DBP or dibutyl phthalate) or on clothes

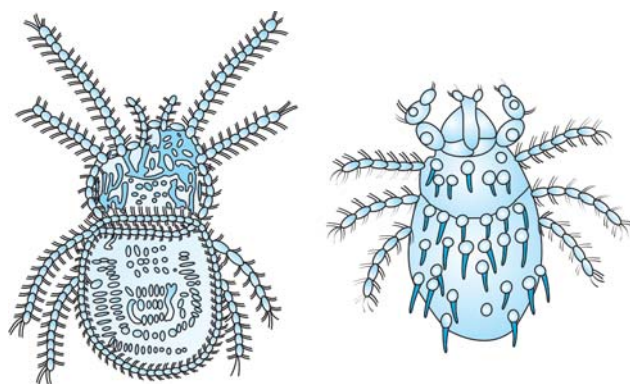


Fig. 11.13: Trombiculid mite

(deet, benzyl benzoate). Clothes impregnated with DBP remain effective for two to four weeks even if washed.

CYCLOPS

Cyclops or water flea is found in fresh water. It is pyriform in shape and is dorsally convex. The head and thorax are fused to form a bulbous cephalothorax while the abdominal portion is narrowed. The head has two pairs of antennae and small pigmented eyes. The size does not exceed one mm and it is just visible to a trained eye. Average life is three months. It is responsible for transmission of guinea worm infection.

Insect Control

Insecticides

Insecticides are substances that kill insects. The term pesticides is a general term including, besides insecticides, rodenticides, herbicides, fungicides, disinfectants and repellents. Till 1936, the major emphasis was on inorganic chemicals such as arsenicals (Paris green), fluorides, mercurials, hydrocyanic acid, sulfur dioxide and methyl bromide. However, their use was restricted because they are injurious to man and pets. Vegetable poisons and chlorinated hydrocarbon were found to be less toxic to man. From 1936 to 1945, plant insecticides such as pyrethrum, rotenone, nicotine and certain petroleum oils were widely used. They were effective against insects but practically nontoxic to man. From 1945 to 1955 chlorinated hydrocarbons such as DDT, BHC and dieldrin were put to extensive use but resistance to them developed over a period of time. Later on organophosphorus compounds such as diazinon, malathion, parathion and dichlorvos became popular. Though they are more expensive and more toxic to man, they are effective against insects that have become resistant to organochlorine compounds. However, insects have started showing resistance to them also. Some other chemical insecticides such as OMS-33 (baygon), and OMS-29 (carbaryl) were later developed. These are safer than organophosphorus compounds if general precautions are taken.⁹

Increasing reports of resistance of insects to chemical insecticides and their toxicity to man (direct and through food contamination) is causing great concern. Consumer hazards due to the increasing use of pesticides in food and agriculture have been evaluated by several expert committees. Organochlorine compounds have been found to be persistent and cumulative and there is evidence of their effect on liver even in low doses.¹⁰ According to one study “Indians ingest more pesticides through their food than any other nation studied. The level of DDT in the body fat of residents in Delhi has been found to be in the region

of 26 ppm on average—well above the maximum residue limit of 1.25 ppm—the highest in the world.”¹¹

The Environmental Liaison Center in Nairobi estimates that 2 million cases of pesticide poisoning occur in the world every year, of which 40,000 die. The international agency PAN (Pesticides Action Network) has identified 12 worst offenders among the pesticides and has labeled them as the Dirty Dozen.¹¹ These are:

1. Campheclor (Toxaphene)
2. Chlodane (Heptachlor)
3. Chlordimeform (Galecron)
4. DBCP
5. DDT
6. The “Drins” (Aldrin/Dieldrin/Endrin)
7. EDB
8. HCH (Lindane)
9. Paraquat
10. Ethyl Parathion
11. Pentachlorophenol (PCP)
12. 2,4, 5-T.

In view of insect resistance and human hazards of the existing chemical insecticides, newer insecticides and newer methods of vector control are being tried. Two important methods are biological and genetic control, discussed later.

CHARACTERISTICS OF A SUITABLE INSECTICIDE

An insecticide, to be useful, should have the following characteristics:

- It should be highly toxic to insects and not to vertebrates.
- It should have persistent action or residual effect.
- It should not be too slow in killing or paralysing the insects.
- Insects should not develop resistance against it.

- It should be economical, easily available and should be soluble in or miscible with ordinary solvents.
- It should not spoil floors or paints.
- It should not give unpleasant smell.

Classification of Insecticides

Insecticides may be grouped as contact poisons (pyrethrum, DDT, diazinon, carbaryl, etc.) stomach poisons (sodium fluoride, formalin), fumigants or respiratory poisons (HCN, methyl bromide) and larvicides (oils, Paris green and some contact poisons). In addition, insect repellents (DMP, deet, indalone) are also used for protection from insects.

CONTACT POISONS²

These are substances that kill insects when the latter come in contact with the substance. The insecticides are absorbed by the cuticle of the insect and cause paralysis of the nervous system. Most are synthetic compounds (organochlorines, organophosphates, carbamates and synthetic pyrethroids) while some are natural ones obtained from plant sources. Contact poisons belonging to different groups are listed in **Table 11.8**. They are briefly described below.

Natural Products and Synthetic Pyrethroids

Pyrethrum: This is an instantly acting insecticide but is effective for only a short duration being highly photo degradable. It is extracted from flower heads of *Chrysanthemum cinerariaefolium* which originated in East Africa but is now successfully grown in Kashmir, Shimla, and Nilgiri Hills.

Pyrethrum is the main insecticide used for space spray and kills insects on their wings in rooms or other

TABLE 11.8: Contact poisons

Natural product (from plants)	Synthetic pyrethroids	Organochlorines	Organophosphorus compounds	Carbamates
Pyrethrum	Prothrin	DDT	Diazinon	Propoxur or Baygon
Derris	Resmethrin	DDD	Malathion	
Rotenone	Bioresmethrin	Methoxychlor	Dichlorvos	Carbaryl
	Allethrin	HCH (BHC)	Parathion	Dimetilan
		Lindane	Chlorthion	Pyrolan
		Dieldrin	Fenthion	
		Chlordane	Abate	
		Heptachlor	Dimethoate	
		Toxaphene	Dioxathion	
		Kepone	Fenitrothion	
		Aldrin	Gardona	
		Endrin	Naled	
		Mirex	Methyl parathion	
			Trichlorphon	
			Chlorpyrifos	
			EPN	
			Ronnal	
			Trichlorfon	
			Dicaphthon	

closed spaces. In the planes and ships, it is used largely to check the spread of yellow fever from one country to another. The active principle is an oily liquid, forming 1 percent by weight of dried flowers. The oil contains 4 complex esters pyrethrins I and II and cinerins I and II, soluble in kerosene or other oils and organic solvents. They are unstable and are destroyed by heat and sunlight. They are harmless to vertebrates. 2.5 percent pyrethrum solution in kerosene or an emulsion with soap and water is required for 1000 cu ft of space (0.1 g/m³). The concentration of pyrethrins in this solution is about 0.1 percent. After spray, the rooms should be kept closed for about an hour. Piperine compounds, piperonyl cyclonene and piperonyl butoxide, enhance the action of pyrethrins and are good synergists or adjuvants when mixed in the ratio of one part with 5 parts pyrethrum. The effect is quicker and more persistent and the kill is greater. Sesame oil, though weaker than piperine in synergic action, is also used as it is cheap. Addition of 3 percent DDT also synergises its action. Pyrethrum may be used as spray, dust or aerosol. For the latter purpose, aerosol bombs or special dispensing devices containing pyrethrum in liquefied freon gas are used.

Rotenone: This is the active principle present in the rhizomes of tropical legumes *Derris* and *Lonchocarpus*. The roots are dried and powdered and used as insecticidal dust. The active principle is extracted in organic solvents. It was widely used against lice and fleas.

Allethrin is a synthetic compound acting like pyrethrin but is more stable and persistent. It is also called 'synthetic' pyrethrin. It is less effective than pyrethrin even in combination with synergists but is cheaper.

Organochlorines (Chlorinated Hydrocarbons)

Ten such compounds are listed below with varying spectrum of use. The most important of these have so far been DDT and BHC, but their use is being grossly curtailed now.

1. *DDT (Dichloro diphenyl trichlorethane)*: It is a white, odorless, crystalline, substance insoluble in water but soluble in organic solvents like kerosene oil. It has high residual toxicity lasting for 2-6 months. In the concentrations used, it is lethal to the majority of common insects but not to their eggs. It is absorbed from the skin and mucous membranes, hence workers should wear gloves, shoes and aprons and should use respirators in closed spaces. Fatal dose is 250 mg/kg, i.e. 1.5 to 20 g for an adult. Cows fed on sprayed grass excrete DDT through milk. This is a warning against indiscriminate use of insecticides and pesticides in the fields. DDT is a cerebrospinal poison. The chief toxic symptoms are tremors, paralysis and convulsions. It also injures the liver

and causes anorexia and vomiting. It depresses bone marrow and may cause purpura. Dermatitis is seen in some cases.

Treatment of poisoning is stomach wash and general supportive measures. Phenobarbitone is given to lessen excitement and to avoid convulsions. Other anticonvulsants may sometimes be necessary. Sympathomimetic drugs should be avoided in such patients, as there is risk of ventricular fibrillation.

DDT has been variously used as 10 percent dust (mixed with chalk or talcum powder, to kill lice), 5 to 7.5 percent water suspension (for spray over mud walls, etc.) 3 to 5 percent emulsion (for cemented and polished surfaces) and as oily solution for space spray when mixed with pyrethrin. However, the use of DDT has been stopped all over the world now, because of widespread mosquito resistance. Moreover, DDT is nonbiodegradable. It was decided to phase out its use in India by March 1997.

2. *Methoxychlor*: It is a cream colored powder. Toxicity being much less than DDT, it is the safest chlorinated compound. Faster in action but less lasting, it is used against flies, fleas, etc. as 5 percent dust or solution.
3. *Benzene hexachloride (BHC) or hexachlorocyclohexane (HCH)*: In crude form it has as number of isomers of which the gamma isomer alone has the killing power. The crude form contains only 10 to 16 percent of the gamma isomer. It is insoluble in water but soluble in organic solvents. It acts on arthropods mainly as a contact poison but, being volatile, it has fumigant action as well. It is more effective and quicker but less persistent than DDT. It kills most insects but not their eggs. Fatal dose is 150 mg per kg. Toxic symptoms are same as in case of DDT. The dust irritates the eyes and respiratory tract. There is no specific antidote. General measures are usually sufficient.

Lindane or gammexane is a preparation containing 99 percent of the gamma isomer. This is the form used most because of its potency. Crude BHC is now seldom used. Gammexane is used as a 0.5 to 1 percent solution for spray and as 5 to 10 percent powder for dusting.

Like DDT, the manufacture of BHC in India was to be stopped after March 1997 with concomitant efforts to switch over from nonbiodegradable insecticides like DDT and BHC to biodegradable ones like melathone and synthetic pyrethroids.

4. *Dieldrin*: Named after Dr Diel, it is a chlorinated cyclodiene, buff or light brown in color, more toxic than BHC but equally persistent as DDT. Toxicity to mammals is higher and it causes epilepsy like symptoms in man. It is used for surface spray

against the insects resistant to DDT and BHC. As a residual spray, the dose is 60 mg per sq foot or 600 mg per sq m. The effect lasts longer than DDT and BHC, up to one year or more. Resistance develops rapidly and is absolute.

5. *Chlordane*: It is a dark brown liquid, nearly odorless, insoluble in water but soluble in organic solvents. It is as persistent as DDT but more toxic. It has been widely used against household and industrial pests such as cockroaches, ants and moths in clothes.
6. *Heptachlor*: It is related to chlordane but is more toxic. It is used widely in agriculture.
7. *Toxaphene*: It is a yellowish solution, used in combination with pyrethrum for knocking down effect in oil sprays and in aerosols for control of household insects.
8. *Kepone*: It is used in 0.125 percent strength as bait for cockroaches.
9. *Aldrin*: It is closely related to dieldrin but is more toxic. It is, hence, used more in agriculture than for domestic use.
10. *Endrin*: It is also used more for soil and plant insects.

Organophosphorus Compounds

- *Diazinon*: The technical product is a pale to dark brown liquid, soluble in organic solvents. Moderately toxic to warm blooded animals, it is very effective against household insects, especially those that have become resistant to DDT and HCH. It is used in 0.5 percent strength.
- *Malathion*: It is a yellow liquid with unpleasant odor. It has the lowest toxicity to mammals and is used in 1 to 2 percent concentration for spray and in 5 percent concentration for dusting the household for control of insects.
- *Dichlorvos*: It is a liquid, miscible with oil or wax. It can be put in dispensers from where it spreads as a fine aerial mist that kills flying insects such as mosquitoes and flies. It is used to disinfect aircrafts at a concentration of 15 to 25 mg per liter of air. It is better than the synergised pyrethrum.⁹
- *Parathion*: It was earlier used widely. Its use is now limited because of high toxicity. Outdoor use to kill mosquitoes and flies may be feasible by impregnating cotton strings or cords with it and hanging them at a suitable place.
- *Chlorthion*: One percent solution is used against resistant cockroaches. It is moderately toxic.
- *Fenthion*: It is used as granules containing 2 percent of the poison for killing mosquito larvae.

Organophosphorus Toxicity

Most organophosphorus compounds inhibit cholinesterases. A decrease in serum cholinesterase is a useful

indication of poisoning. If the level falls by 40 to 50 percent from normal, it is a danger signal for removal of the employee from further contact with the pesticide. Acetylcholine, normally inactivated by cholinesterase, accumulates in blood and parasympathetic activity increases. Early symptoms are sweating, salivation, increased bronchial secretions, vomiting, colic, diarrhea, blurred vision, muscular cramps and tremors. Bradycardia, hypotension collapse, contracted pupil and coma follow.

The symptom complex of increased secretions, asthmatic breathing, muscle tremor and convulsions is suggestive of poisoning. Death occurs due to pulmonary edema and respiratory failure. Death may follow not only accidental poisoning but also suicidal attempt. Diazinon is frequently used in the latter case.

The treatment of cholinesterase inhibiting organophosphate poisoning¹² consists of:

- Complete rest
- Atropine (antidote) 2 mg IV slowly and repeated every 10 to 12 minutes till pupils dilate. Smaller doses may have to be continued for 24 to 28 hours
- Oximes (pralidoxime) 1 g in 5 ml water IV. If not available, blood transfusions should be tried
- Frusemide (Lasix) 40 to 80 mg IV (for pulmonary edema)
- Care of respiration
- General supportive measures.

It should be noted that atropine is virtually ineffective against the autonomic ganglionic actions of acetylcholine and against peripheral neuromuscular paralysis (which is responsible for muscle weakness and respiratory muscle paralysis). This is because the organophosphates form a phosphate ester bond at the enzyme active site. This bonding can be reversed by pralidoxime, marketed by Unichem as paralidoxime methane sulphonate (also known as PAM-Pyridoxine Aldoxine Methane sulphonate). Pralidoxime is given in a dose of 1 g in aqueous solution administered intravenously over a five minute period. If adequate improvement does not occur, the dose may be repeated three to four times every 8 to 12 hours. Morphine, aminophylline and chlorpromazine are contraindicated. Diazepam and other anticonvulsants (phenobarbitone) may also need to be given.

Carbamates

Carbamate compounds are safer than organophosphorus compounds. Their residual effect persists for three months. The toxic effects are similar to organophosphorus compounds but are milder. No cumulative effects are seen. The principles of treatment are same as in case of organophosphates, except that pralidoxime should not be used.⁷ Two carbamates in common use are:

1. **OMS-33 (Baygon):** The chemical name is O-isopropoxyphenyl methylcarbamate. It is used with success as 1 percent spray against mosquitoes, flies, bugs, fleas, and cockroaches.
2. **OMS-29 (Carbaryl):** The chemical name is anaphthyl methylcarbamate. It is used as dip or wash for infested animals is 0.5 percent strength and as dust (2-5%) against ticks, fleas, culex, bugs and cockroaches.

STOMACH POISONS

Contact poisons act as stomach poisons also, especially in case of bigger insects such as cockroaches. They are absorbed from the midgut. Those which have been in common use are:

- **Sodium fluoride:** 2 percent watery solution has been used for killing ants.
- **Formalin:** It can be used on strings to kill flies.

Fumigants

They are gaseous compounds such as HCN and SO₂, that prevent cellular respiration. Fumigation requires elaborate arrangements and involves high cost.

Cyanogas or Ca(CN)₂: Used with moisture, it liberates HCN gas. It is very efficient but is also toxic to animals other than insects and pests.

Sulfur dioxide: It has poor penetrating power, low toxicity and a tendency to bleach dyes. As a result, it is not used very much.

Methyl bromide: It is a colorless, odorless volatile liquid 2 to 3 times heavier than air. It is highly penetrating and inflammable and spoils paints. It is poisonous for man and has cumulative toxicity. It is used for warehouse fumigation.

Chlorpicrin: It is a slowly volatile yellowish liquid used as tear gas in the first world war. Some people prefer it to hydrocyanic acid for household fumigation.

Carbon disulfide, carbon tetrachlor, ethylene dioxide, etc. can also be used.

Repellents

Repellents are chemicals that prevent or deter arthropods from attacking men or animals. They are used for individual protection when insect control is not feasible. A good repellent should give protection for a reasonable period (6-8 hours), should be nontoxic and nonirritant to skin, should not spoil clothes, should be easy to apply and should not have an unpleasant odor. Some people are allergic to them. Most effective ones in use are:

- Benzyl benzoate
- Butylethyl propanediol
- Deet (N, N-diethyl-m-toluamide)

- Dibutyl phthalate
- Dimethyl carbate
- Dimethyl phthalate
- O-chlor-diethylbenzamide
- Ethyl hexanediol
- Indalone.

All purpose mixtures are also available. Examples are:

- **M-2020:** It contains dimethyl phthalate (40%), dimethyl carbate (30%) and ethyl hexanediol (30%).
- **M-250:** It has dimethyl phthalate (60%), ethyl-hexanediol (20%)m and Indalone (20%).

Repellents are formulated as liquids, solid waxes, creams and aerosols (in pressurized containers). They are applied in two ways:

1. Rubbing on the exposed parts of skin by hand.
2. Impregnation of outer clothing at a standard rate of 20 g per m² or application of total 70 g to clothing worn from head to foot. Emulsions or mixtures are suitable for this purpose.

The level of protection depends upon the nature of repellent, its dose, mode of application, nature of insects, climate, etc. and varies from a few hours to weeks. Deet, butylethyl propanediol and benzyl benzoate are best suited for clothes and should not be applied to skin. Ethyl hexanediol, dimethyl carbate. DMP and indalone can be applied to skin. Benzyl benzoate and DBP are not affected even if clothes are wetted but in the case of others, clothes should be retreated if they become wet. Repellents should be applied when clothes are dry. Clothes should be retreated after laundering. Deet is the best repellent against winged insects and benzyl benzoate against fleas.

Larvicides

- **Petroleum derivatives** such as diesel oil and special oils for mosquito larvae such as malarial are sprayed over water surface at the rate of 20 to 50 liter per hectare.
- **Borax** is effective against larvae of houseflies.
- **Paris green** (Copper acetoarsenite) is a stomach poison, available as a green powder, and is used as 1 to 2 percent dust or pellets (5%) after mixing with ash or soapstone. It is sprayed on water surface at the rate of 16 kg/ha with the help of ground machines or aircraft.

Organochlorine and organophosphorus compounds are also used as oily solutions for larvicidal purposes.

Safety Measures while Using Insecticides

- Wearing of protective equipment such as hats, plastic net weils, light plastic caps, cotton overalls, rubber boots, face masks and respirators (masks with cartridge or canister) to protect against toxic vapors, gases or droplet.

- Display of cautionary notices.
- Removal of worker at the earliest sign of poisoning.
- Removal of unabsorbed material from the body and change of clothes.
- Early general and specific treatment.

Insecticide Resistance

Insecticide resistance has been defined as the development of ability in a strain of insects to tolerate doses of toxicants which would prove lethal to the majority of individuals in normal population of the same species.¹³ Most disease vectors have developed resistance to common insecticides. This has caused a great concern to public health workers and has upset the vector-borne disease control programs.

Many species of anopheline mosquitoes have become resistant to dieldrin and DDT. Increased tolerance to malathion has developed in some species. Fleas and lice in some places have become resistant to organochlorines. Resistance to warfarin is reported in *R. norvegicus* and *Mus musculus*.

Problems arising out of resistance against organochlorine insecticides were solved to some extent by organophosphorus and carbamate insecticides though they are more expensive and toxic. Alternative chemical insecticides and methods of control must be continuously found to meet the challenge of insects.

Resistance has been found to be due to single principal genes in nearly all cases. Usually DDT resistance is recessive in nature while organophosphorus resistance is dominant and that of dieldrin intermediate. Some insects develop resistance to a specific insecticide while others tend to develop resistance to insecticides in general. Methods alternative to the use of insecticides, being encouraged by WHO, are biological control and genetic control.

Biological Control of Insects

Before introducing a biological control agent against the pests, its effects on human beings and nontarget organisms should be taken into account.

Predators: Introduction of larger animals to which the pests fall prey has been used for this purpose. Two species of mosquito fish, *Gambusia affinis* and *Lebistes reticulatus* have been effectively used to control larvae but their use is not extensive.

Several species of 'annual' fish (Cyprinodontids) can be used for mosquito control in alternately flooded and dry areas.

Pathogens and parasites: *Coelomomyces* fungus has been used for control of *anopheles* and *culex* mosquitoes. *Bacillus sphericus* and *B. thuringiensis* have been successfully tried as biopesticides against *culex* and *anopheles* respectively.

Genetic Control

It has been defined as 'the use of any condition or treatment that can reduce the reproductive potential of noxious form by altering or replacing the hereditary material.'¹⁴ The method that has received most attention is release of males sterilized by gamma irradiation or by chemosterilants. Insects are induced to feed on baits or to enter traps treated with chemosterilants. This method has been successfully tried for mosquito control. Sterilized males are released in large number. They mate with wild females in natural population and nullify their reproductive potential.

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Social environment is as important as the physical and biological environments in relation to health and disease in man. The effect of social environment on health is clearly reflected in the differences in morbidity patterns of rural vs. urban areas and developing vs. developed countries. Many important public health problems are closely related to the lifestyles of people in different societies. Examples of such problems are obesity, coronary heart disease, hypertension, diabetes, sexually transmitted disease, AIDS, psychiatric disorders, suicides, accidents, alcoholism, drug abuse and delinquency.

Socioeconomic and political factors are important determinants of health. This is dramatically reflected in the comment of Naina, wife of Boris Yeltsin, Prime Minister of Russia that, "We have astronauts flying in space ships, but we do not have enough wheel chairs".¹ In USA, in spite of the most sophisticated advances in medicine, even family planning and immunization services are not available free, as in India.

The term *social environment* denotes the complex of psychosocial factors influencing the health of the individual and the community. In view of the multiple nature of factors involved, it may be more appropriate to use the term *psychosocioeconomic environment*. This environment is unique to man and includes, cultural values, customs, habits, beliefs, attitudes, morals, religion, education, income, occupation, standard of living, community life and the social and political organization.

Social Sciences

It is essential to have proper understanding of social sciences in general and of sociology in particular in order to fully appreciate the impact of social environment on man. The *five social sciences* include Sociology, Social or cultural anthropology, Social psychology, Economics and Political science. The first three together constitute the behavioral sciences, since they deal with the behavior of man as a reaction to the conditions in the society. A brief description of the scope of various social sciences is presented below. Sociology, including medical sociology, is described in greater detail.

Sociology

Sociology is the science concerned with the organization or structure of social groups. It studies the kinds and cause of variation in social structure; and the processes by which the intactness of social structure is maintained. It is the science of behavior of man in a society or group of human beings. The behavior of man depends very much upon his relationship with other fellow beings. Man is the subunit of a small group, the family, while the family is a subunit of society. Man's behavior is affected not only by his physical and biological environment but also, to a much larger extent, by social environments represented by his family, society and government. In particular, the behavior or attitude of a child who is in his formative years is affected by his parents, playmates, schoolmates, teachers and neighbors.

The scope of sociology can be gauged from its various specialities which include, among others, medical sociology, occupational or industrial sociology, educational sociology, urban sociology, rural sociology, criminology and sociology of religion.

Society

Society is a major concern of sociology. In a layman's language society is a group of people. But the members of such a group must be mentally aware of each other. For example, a group of people standing in a queue cannot be called a society. They are only aware of each other at a physical level, acknowledging each other's physical presence. Communication at psychological or mental level, which will establish them as a society, is not present. They are aware of the presence of others, but know nothing of their aims, aspirations, ideals and needs. Thus we see that mutual awareness or reciprocal recognition at the psychological level is a pre-requisite to the formation of society.

On the other hand, patients admitted in a hospital ward may qualify to be called a society or a social group. They share a common factor of suffering and often have common problems and aspirations. Thereby they change from "individual" to "group", from "I" to "we". This "we" feeling, the group feeling that "I am not alone, there are many more like me",

is the essence of society. In short, society may be defined as an organization in which all members have social relations among themselves. Sociologists define society as “a system of uses and procedures of authority and mutual aid of many groups coupled with division of control of human behavior and liberty.”

ORIGIN OF SOCIETY

Society exists in animals also. The two basic instincts—hunger and sex—are the two manifestations of a single broad driving force or motive, i.e. the urge for survival. If an animal eats, it does so in order to survive as an individual. If it reproduces, it does so in order to survive as a species. These activities give rise to a biological-social network. Animals move in groups called herds. Group activity gives a sense of security.

Let us consider how human society differs from animal society. In order to understand this, we have to trace the evolution of man. Six evolutionary events have contributed to ultimate development of human society. These are described below:

- 1. Breastfeeding:** With the change from oviparous to viviparous mode of reproduction, mammals started feeding breast milk to their young ones. This fostered group life physically as well as mentally. Nourishing the baby developed in the parents a sense of attachment and concern. This was particularly marked in man, in whom only one baby took birth at a time and breastfeeding was prolonged.
- 2. Upright posture:** This enabled man to free his hands. As a result, man was enabled to manipulate nature and perform various activities.
- 3. Development of thumb and its circumscribed movements:** On the one hand, this imparted extra strength to hand in the form of clenched fist. On the other, man was enabled to perform finer and complex movements.
- 4. Development of brain:** The above mentioned bodily changes were accompanied by physical and functional alterations of the brain. Brain kept on developing, along with memory and language.
- 5. Controlled fertilization:** Physiological and psychological aspects of sex became more advanced and complicated in man. Estrous cycle in mammals was replaced by a regular menstrual cycle in man. These regular menstrual cycles are helpful in two ways. Firstly, conception can take place during any period; secondly, it can be prevented also. Thus, in human beings, there is a controlled fertilization. This is also in favor of living together in a planned manner.
- 6. Cultural development:** The above five elements can be identified in many animals in varying degree. But man has added one more component to the above mentioned points, namely, the element of *culture*. It can be simply understood as “An art of adding experience”. This addition can be done by

telling something to the fellowmen of the same generation as also to the next generation. So, with this extra element, man has given himself the name social animal. In contrast, animals either inherit certain instincts or gain experience through hit and trial approach which, however, remain limited to their own life time. Man, on the other hand, learns from the experience of others as well and can plan for the future. In other words, he works in the shadow of the past for a better tomorrow.

STRUCTURAL ASPECTS OF SOCIETY

Social institutions: A social institution is a social structure through which human society organises, directs and executes the multifarious activities required to satisfy human needs. Institutions may be economical, political, educational, religious and recreational in nature. Examples are a school, hospital or parliament. Family, *per se*, is also a social institution. It is described in detail later on.

Community: It is defined as the group, small or large, living together in such a way that the members share not one or more specific interests (like occupational, educational, etc.) but rather the basic conditions of a common life. The hallmark of a community is that one’s life may be wholly lived within it. One cannot live a whole life within a club or a business group. However, one can live wholly within a tribe or a village or city.

Associations: Associations are groups of people, united for a specific purpose or a limited number of purposes and are based on utilitarian interest, e.g. Junior Doctors’ Association. When an association serves a broad interest and does so in an accepted, orderly and enduring way, it may be called an *institution*, i.e. as established way of doing things. An example would be the Indian Medical Association.

The society is a web of social relationships. It is an organization created by man for himself. Individuals in a society are expected to play a number of roles through their relationships. The strength of relationships decides the nature of a group. These relationships may be primary or secondary in nature. Likewise, the character of the groups may be primary or secondary. This is described in **Table 12.1**.

Doctor-patient relationship: The nature of Doctor-patient relationship is a debatable topic. If we just look at it from the physician’s point of view, it seems to be a secondary relationship because:

- It is a professional relationship, i.e. business deal.
- It starts from a particular date and it ends after the treatment is over.
- It is transferable.

However, if we consider the relationship from the point of view of the patient’s psychology, the following points go in favor of a primary relationship.

TABLE 12.1: Primary and secondary relationships and groups

Primary groups (Primary relationships)	Secondary groups (Secondary relationships)
<p>Relationship is spontaneous, continuous and informal</p> <p>No specific date to start and no specific end of relationship</p> <p>It is a permanent group. There is a contact</p> <p>The basis of group is Emotion</p> <p>Relation is first. Motive is secondary</p> <p>It is "face to face" or related with "we" feeling</p> <p>The relation is present even if the group is not physically there</p> <p>The relation is not transferable. It cannot be replaced by anyone else the first one as in business deals</p> <p>There is a unique sense of satisfaction attached with the particular person</p> <p>Example: Family, friends</p>	<p>Relationship is nonspontaneous, noncontinuous and formal</p> <p>The relation starts on a particular date and ends with a specific date</p> <p>It is a temporary group. There is a contract</p> <p>Underlying basis is business</p> <p>Motive is first. Relation is secondary</p> <p>No such feeling</p> <p>No relation or group feeling after the contract is over</p> <p>It is transferable relation. Any person can come and replace the</p> <p>There are no emotions and no such feelings are present</p> <p>Example: Business deals, classmates, etc.</p>

- Though the relationship starts after a particular disease, it is often continuous in nature. Illness keeps on occurring frequently and, by and large, patients have a tendency not to change the doctor. Most people have their family doctors, the relation with whom is continuous.
- The doctor-patient relation is more than a mere professional or money relation. Without an element of emotion on the part of the doctor and without an element of faith on the part of the patient, the treatment cannot be fully unsuccessful.
- The relation is not transferable from the patient's point of view. For example, a patient wishes to see the same doctor on a follow-up visit even in a government hospital. If his own doctor is not available, a patient would prefer to visit again and see his earlier doctor rather than be seen by a new doctor on each visit.

FUNCTIONAL ASPECTS OF SOCIETY

We have already said that society is an organization made by man for himself. So he has framed the procedures also. Every living organism has some basic requirements and tries its best to satisfy them. In animals, these needs give rise to the basic desires or instincts which the animal tries to satisfy without inhibition. In man, the biological forces trigger the desires but, contrary to animals, there are social standards which guide man. The resultant of these two forces is the actual behavior, which we perform in society. A newly born child is equivalent to an animal. Whenever he feels hungry, he starts crying and keeps on crying till his desire is fulfilled. As the child grows, he can be made to understand that "please wait, food is not ready" and the child can resist his hunger. The day to day teaching and learning constitutes an important functional aspect of society.

Social Norms

Every society specifies certain rules of conduct to be followed by its members in certain situations. These

specified rules of conduct are technically known as *social norms*. Various social norms and their origins are explained in **Figure 12.1**.

Various types of norms, can be considered according to— Range of acceptance and Range of enforceability.

Folkways: They refer to customary ways of behavior. People conform to these ways not out of fear of being penalised but because it is obligatory in the proper situation. They are enforced by informal social controls like gossip and ridicule. Their origin is usually unplanned and obscure. Examples of such expected forms of behavior include the ways of greeting, dressing, eating, etc. Folkways vary from society to society and culture to culture. Certain folkways may be common, but otherwise they lend uniqueness to a culture. They are necessary for the group solidarity. Vitality of a group is indicated by the extent to which people follow or abide by folkways.

Mores: Mores are socially acceptable ways of behavior that involve moral standards. There is greater feeling of horror about violating mores and greater unwilling-

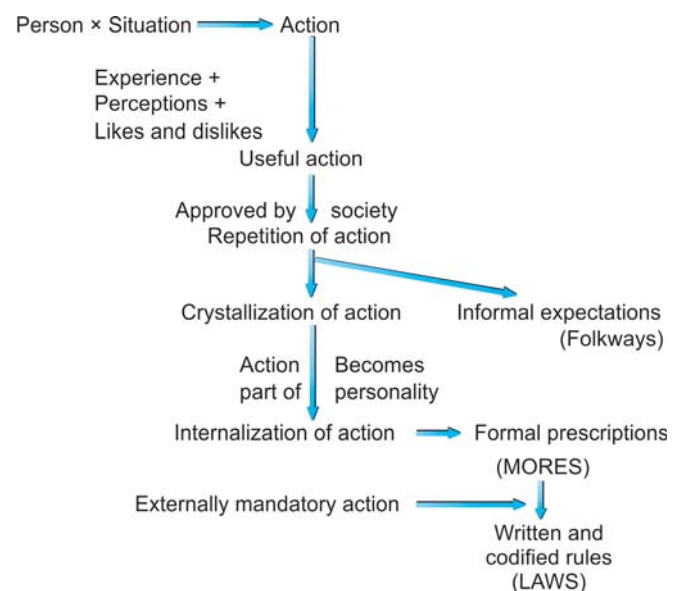


Fig. 12.1: Types of norms

ness to see them violated. While each folkway is not considered tremendously important and is not supported by an extremely strong sanction, each more is believed to be essential for social welfare. Sanctions are informal and the reactions of the group are spontaneous rather than official action. This is transformation of informal expectation (Folkways) to formal prescriptions (Mores).

Taboos are the specific types of mores expressed in negative. Examples are abstinence from beef, pork and smoking in Hindus, Muslims and Sikhs respectively and from marrying outside one's own ethnic, caste or religious group.

Laws: Some important mores are converted into law in order to ensure implementation. This is the last step in the formulation of rules of conduct in a society. Laws are not only prescribed in written form but are enforced through specific machinery created by society for this purpose.

We can illustrate the concept of folkways, mores and laws through the example of marriage. The institution of marriage involves several obligations such as:

- Barat or the marriage party
- Performance of garlanding ceremony
- Bridal dress
- Seven rounds around the fire, i.e. Saptapadi in Hindu marriage
- Some form of dowry, etc.

These obligatory ways are all expected to be performed. Some of these may be violated, such as those relating to the number of persons in the marriage party, garlanding ceremony, dowry, etc. However, this is condemned only at whispering level. On the other hand, it is never expected that a boy may come alone to the bride's house asking the parents to send their daughter with him. Some witnesses, at least, must be present and Saptapadi must be performed. Without these, marriage may be a nullity in law. Thus if the society feels that its vital or organic essence is in danger due to violation of some conduct or mores, these are written and codified, e.g. Marriage Act, Anti-dowry Act, etc.

Customs and Habits

Custom is a broad term embracing all the norms classified as folkways and mores. It refers primarily to practices that have been repeated by a number of generations, practices that tend to be followed simply because they have been followed in the past. Customs have a traditional, automatic, mass character. On the other hand, a *Habit* is a purely personal affair, not entailing any obligation. Examples are having a cup of bed tea, smoking a cigarette after dinner, eating two meals a day, bathing daily, etc. When habits are shared for their necessity and are sanctioned by the society, they are converted into customs in due course of time.

Etiquettes and Conventions

Etiquettes are concerned with choice of the proper form for doing something in relation to other people. Convention is merely an agreed upon procedure. Thus entering a bus from the rear with exit from front is a convention. When a procedure is adopted and repeated time and again, it may become a rule.

Social Values

Like social norms, values also constitute an important part of the selective behavior of man. Values refer to those standards of judgment by which things and actions are evaluated as good or bad, moral or immoral, beautiful or ugly. Thus values are directive principles of human action and serve as criteria of selection. Norms and values are not the same things. It is said that norms are the enactment of social values. Every society lays down certain rules of conduct to support its value system. Norms are repeated, sanctioned pattern of behavior and their philosophical facet is the value. For example, it is a *norm* that no man should be differentiated in terms of sex, caste, color or creed while practising the art of medicine. The *value* behind it is that "all men are born free and equal."

Cultural Anthropology

Anthropology is the study of man and his works. It has two broad divisions. *Physical anthropology* is the study of man as a biological organism. *Cultural anthropology* is the branch dealing with man's behavior and products. Its major theme is *culture*, which is defined as the accumulation of learned behaviors, beliefs, skills, etc. of the mankind as a whole. The two main branches of cultural anthropology are ethnology and archeology. Linguistics is sometimes regarded as a third branch of cultural anthropology. *Ethnology* is the comparative study of cultures. *Archeology* is the study of past cultures and civilizations and uses their remains as the principal source of information. *Linguistics* is the study of speech patterns of man, i.e. the study of languages and dialects. *Social anthropology* is a specific branch of cultural anthropology dealing with comparative study of kinship and nonkinship organization patterns in different societies.

Culture means socially inherited characteristics of human groups. It comprises everything which one generation can tell, convey or hand down to the next. In other words, it has nonphysically inherited traits. The Oxford English dictionary defines *culture* as, "the training and refinement of mind, tastes and manners, the condition of being thus trained and refined". Man is distinguished from animals by virtue of the fact that he possesses a culture, i.e. he can speak, can frame ideas and has manners, customs, etc. He is humanist,

has sympathy towards others and understands his fellow beings. Man learns from his fellow beings and the society regarding how to behave towards others. Ways of life are cultivated or cultured in an individual by others in the group and the individual becomes social or civilized as a result.

Culture has three parts. It is an experience which is “learned, shared and transmitted”. We can also say that culture is a social heritage, a product of specific and unique history. It is the distinctive way of life of a group of people, their complete design for living. *Civilization*, on the other hand, is the whole machinery or system of devices developed by man.

Social Psychology

It is collective mentality as distinct from individual psychology. It deals with human nature and attitudes in general. Social psychology studies how and why perceptions, thoughts, opinions, attitudes and behavior vary in different groups and societies. In other words, it studies the effect of social environment on individual psychology. Every human being in a society has a mental need for love, security, understanding and freedom of thought and expression, etc. If such need is not satisfied, both his body and mind may be adversely affected.

Economics

It studies the economic aspects of man, i.e. productions, distribution and consumption of the three basic essentials for his living, namely, food, shelter, and clothing. Scarcity or excess of these are found to affect human behavior. Economics is hence closely related to behavioral sciences, especially sociology. The three levels at which economics operates in relation to man and society are as follows:

- 1. Individual level:** In economic term, health is more or less a purchasable commodity, even though the government has strived to provide health services free to the people. This is evident from several studies showing that people depend more upon private health services than the government health system for a variety of reasons.^{1a}
- 2. Individual-community interface:** The relation between economic development and health has been well recognized even though poverty is never mentioned as a cause of disease in medical records. Poverty is, in fact, the biggest single cause of death, disease and suffering in the world.¹⁶ Poverty means less access to food, clean water supply, sanitation, vaccination and medical care, all of which lead to disease or death. The following facts are obvious in this connection:
 - Physical health of poor people is unsatisfactory. Inadequate availability of food, clothing and

shelter decreases the defence mechanisms of the body.

- Communicable disease are related to low standard of living in a community.
- Social ill health is more common in low socio-economic groups. Examples are drug abuse, childhood delinquency, sexually deviant behavior and general crime and violence.

3. State level: Allotment of budget and public health are very closely related. If the people are not healthy, they cannot contribute to progress and economic upliftment of the country. For example, it has been estimated that economic loss due to malaria is much more than the cost of antimalarial operations.^{1c}

Health economics is described in detail in Chapter 27.

Political Science

The meaning and scope of political science has become more and more comprehensive over years. A modern definition is by Easton, according to whom “Political Science is the study of the whole political system”. The political system is that set of interactions through which authoritative allocation of values are made and implemented for a society. An authoritative allocation of values involves power, authority, conflict, consensus and, above all, the dynamics of decision making. Implementation of the allocated values involves use of force and coercion by the decision makers against those who refuse to abide by them. Thus the definition given above looks at the concept of political sciences in a comprehensive manner.

Health is a state responsibility. As laid down in the Constitution of India, “The state shall, within the limits of its economic capacity and development, make effective provision for securing the right to work, to education and to public assistance in case of unemployment, old age, sickness and disablement”. Also, “The state shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of the public health as among its primary duties... ” Article 47. It is important to realize that the politician can play a crucial role in health. Within the limited resources, it is he who fixes the priorities. It has been aptly said that “The solution to many of today’s problems will not be found in the research laboratories of our hospitals, but in our parliaments. For the prospective patient, the answer may not come by incision at the operation table, but by prevention through decision at the Cabinet table.”

Relationship Amongst Social Sciences

Social sciences are interrelated disciplines that deal with man’s relationship to his physical, social and cultural

environments.² Out of the five social sciences mentioned earlier, the three behavioral sciences—sociology, social psychology and cultural anthropology are obviously closely related. They deal with social behavior of man, i.e. the behavior of man with his fellow beings. As a matter of fact, social psychology is very closely linked to sociology and there is great deal of overlapping between sociology and cultural or social anthropology.

As regards economics and political science, both are interlinked. Historically both have developed as a single discipline. For example, Plato in his “Republic” and Aristotle in his “Politic”, have discussed both economics and political science in a single text. Their essential oneness, and their relation to sociology, will be clear when their historical evolution is considered. There was a stage in human evolution when, from *hunter*, man became a *gatherer*, i.e. he began collecting the food for the next meal or next day. This was a trigger for settled life. In a settled dwelling situation the animals collected by man started producing offsprings. At the same time, cultivation of vegetation unveiled a new chapter of production. Thus from gatherer, man became a *producer*. Production can be called the base of today’s society. Production is related to distribution because, after consumption of required amount of food, the question of distribution arises. The discipline which studies the production and distribution of goods by man has been given the name *economics*. As the economic process develops in a society, it influences and is influenced by the social life of man. The economic system is embedded in the social structure as a part of it. Hence social setting, social change and economic change, all must be studied together to understand each other fully. It has, in fact, been said by sociologists that economics is the handmaid of sociology.

Production and distribution functions are related to the concept of ‘Having’. To have at first and then to distribute, means one is higher in status. Power of distribution or, in other words, power to govern, is next to economic relationship. From the historical point of view, the affinity between sociology and political science is very close. Today, political science has developed into a full fledged discipline. Some of its branches are of direct concern to sociology, e.g. the relation between law and freedom, the relation between administrative authority and mutual help, etc. On the other hand some branches of political science are too specialised, such as system and nature of law, methods of political representation and spheres of legislative power, etc.

Medical Sociology and Social Medicine

Disease is basically not being at ease, i.e. disease. In other words, it is a feeling of not being comfortable. The cause of discomfort or ‘disease’ need not always be physical or organic. It may be related to purely

mental or social environmental factors such as a problem boss, colleague or subordinate.

In spite of the advancement of scientific knowledge in the field of molecular biology, biotechnology, etc. we still do not know “*Why do people behave as they do*”? There is massive food grain production at the global level, yet men are hungry. We have plenty of medicines, yet people are dying of disease. Technological advancement alone is not the complete solution. Science can give us medicines, but how to provide them to people is often a sociological issue.

The effect of environment, including social environment, on human health has been known for centuries. However, the concern for social factors in health got overshadowed with the emergence of the germ theory of disease. As infatuation with the germ theory subsided, it was noticed that:

- The major interest had been focussed upon the treatment of disease and not upon prevention of disease and promotion of health.
- Medical men were more interested in the classification of disease than in the real cause or causes of disease.
- Rather than being interested in the individual as a whole person, medical science was more interested in a component of the individual where the pathology was supposed to be located.
- There was more interest in the immediate effect of a disease rather than in the interrelation between disease and society.

In view of the above realizations, medical sociology developed as a special branch of sociology. The development of this branch was initiated by Charles McIntire in 1894. *Medical sociology* is defined as “Professional endeavor devoted to social epidemiology, the study of cultural factors and social relations in connection with illness and the social principles in medical organization and treatment”. Medical sociology studies social factors in relation to preservation and maintenance of health, etiology, occurrence and management of disease and disability and, in general, the practice of medicine and functioning of medical institutions. It is a study of factors related to the family, the society and the state (government) which are responsible for health or disease in the individual or the community.

In the above background there was gradually felt a need for social medicine with the following aims.

- To study man as a social being in relation to his total environment, social as well as physical.
- To pay particular attention to those forces in socioeconomic sphere that directly or indirectly affect man’s health.

Social medicine has been defined as—“The study of the social, economical, environmental, cultural, psychological and genetic factors which have a bearing

on the health of groups of individuals and individuals within these groups and, at the same time, with practical measures within the social field that may be taken to promote health, prevent disease and assist recovery of the sick.”

Family

Family is the basic unit of society. It is the germinal cell from which the society at large develops. In a family, the man and woman may be going to work and children may be going to school. The man may be a member of some political party, the woman may be attending a religious gathering and the whole family may go to a theatre. But, ultimately, they all come back to one dwelling, under one roof. Thus we can say that all other institutions are peripheral to the family. One can be a member of several institutions, but one cannot spend his whole life in those institutions. Family is a nuclear unit upon which the life of the society depends.

The origin of family, the basic social unit, is primarily biological. Sex is a basic need, the sexual impulse being related to the instinct of self preservation of mankind. Breastfeeding serves to enhance parental attachment and affection. Keeping the child to the breast produces the sense of oneness, emotional affiliation and possessiveness. This possessiveness and, in turn, dependence of the child, grow mutually. Pregnancy, delivery and lactation are, no doubt, physiological processes, but women need help and cooperation during these periods. This help and cooperation component adds the sense of sociality to the biological unit.

In view of the foregoing, the *family* is defined as “a group characterized by a sex relationship sufficiently precise and enduring for the procreation and upbringing of children.” It has also been labelled as “the residential unit of society”. Its main characteristics are that it is universal as an institution and that it functions as a corporate unit.

FUNDAMENTAL FEATURES OF FAMILY

Universal nature: Family is the most universal form of institution. It is found in all societies and also exists in subhuman species. Everyone is or has been a member of a family. It is universal and permanent as an institution but, as an association, it is transitional. The family in which one is born is called the family of origin or family of orientation. The family in which one marries as known as the family of procreation.

Emotional basis: It is based on two types of instincts and emotions.

- Primary instinct of organic nature, i.e. of procreation, mating, maternal devotion and parental care.
- Secondary type of emotions, e.g. romantic love, pride of race, jealousy, personal possession.

Economic unit: One of the most important features of the family as that it functions as an economic unit, both for production and consumption. It is the best example of socialized pattern, i.e. work according to capacity and maintenance according to need.

Responsibility of members: It is a form of active cooperation amongst various members. Everybody is assigned a responsibility. Elders look after and nourish the children and educate them. Males busy themselves mainly with outdoor activity and physical protection. Everyone is responsible for some work. Some members have the responsibility of looking after others, e.g. care of infants, pregnant women, lactating mothers, the old, the sick and the handicapped.

Formative influence: It is the earliest social environment, i.e. it is the first contact of man with social environment. The family has the highest formative influence on children born in the family. It is a very well known proverb that, ‘civilization starts from the home’.

Education: Besides providing for the material needs of the offsprings, an important role of the family is to inculcate in their mind the ideas, ways and customs of the group by elders in the family. The family is the most effective agency for transmission of the cultural heritage from generation to generation. From sex education to business techniques, all are taught in the family.

Limited size and nuclear position: It is necessarily a group of very limited size, defined by biological relationship which it cannot transcend without losing its identity.

FUNCTIONS OF FAMILY

The five basic functions of *family* are:

1. Sexual gratification
2. Procreation
3. Legitimization of birth of children
4. Socialization and enculturation
5. Acting as an economically viable production-consumption unit.

It may be emphasized that socialization and enculturation is an extremely important function of the family. It includes.

- Primary socialization of children so that they can truly become members of the society in which they are born, and
- Stabilization of the adult personalities in the society.

TYPES OF FAMILY

The family in which the individuals are born is called the *family of orientation*. The family that the individual creates after marriage is called the *family of procreation*. There are three basic types of families: nuclear, joint and extended. The *nuclear family* is the simplest form consis-

ting of husband, wife and unmarried children residing under the same roof. The *joint family* is a lateral extension of the nuclear family in which the families of siblings live together. The joint family may have a number of variations such as a married man with his family along with unmarried sister or brother living together. The *extended family* is a linear extension of a nuclear family and consists of husband, wife and their married children living together. The most common type of “joint family” found in India is really a joint extended family in which the husband and wife live together under the same roof along with their *married children*. Examples of various types of families are illustrated in **Figure 12.2**. In general usage, the term joint family includes all such combinations as distinct from the nuclear family. In the nuclear family the husband and wife, along with their offsprings, act as a nucleus. All other relatives are present around the nucleus. Even the old parents are outside the nucleus. It is a *conjugal arrangement*. The joint family can be pictured as the nucleus of blood relatives surrounded by a fringe of spouses. In this case the husband and wife, along with their sons and daughters form the nucleus. Daughters in law and sons in law and persons from the maternal side are not included. Thus it is a *consanguineous arrangement*. The major decisions in a nuclear family are taken by the husband and wife, the husband acts as the head of the family. He may not take into confidence even his father, to whom the decision may just be conveyed. In a joint family the major decision is taken by blood relatives.

The matrimonial alliance in a family may be monogamous or polygamous in nature as described below.

Monogamy: It is a type of sex relationship (marriage) where one male and one female decide to live together.

Polygamy: In this system, one male or female decides to live with more than one member of the opposite sex. It is more common for a man to have more than one wife (polygamy) rather than the opposite (polyandry).

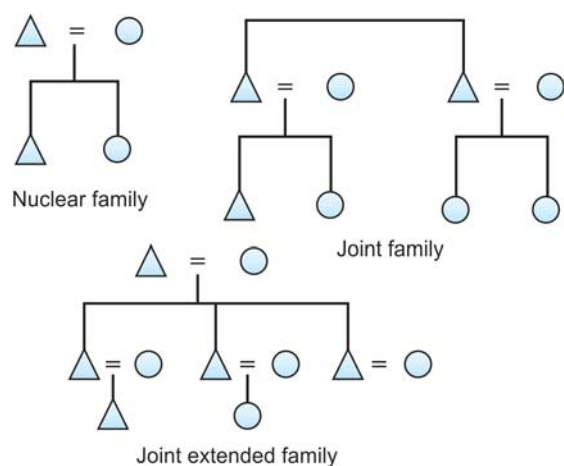


Fig. 12.2: Different types of families

The latter is still practised in certain hilly and tribal areas, such as Himachal Pradesh. This system helps to provide more male working hands in the hill culture where life is strenuous. It also helps to keep the family land holding relatively intact because all male adults in a polyandrous relationship belong to one and not different families. Thus all brothers marry with a single female.

The family system prevalent in the world today is patriarchal. This means that the father is the principal legal guardian of the child and gives him his name. He is the head of the household and the owner of family property. It is he who takes major decisions in the family. In some societies, especially in tribal and hilly areas, matriarchal system of family prevails where mother is the principal person in the family. Such system is still common in some parts of Africa. In India, it is found to Kerala and the North East, though it is fast giving way to the patriarchal system. From the point of view of social security, especially to women and children, the matriarchal system is better. The patriarchal system has an inbuilt gender bias against women. Patriarchal values need to be challenged in order to provide a gender-just environment to girls and women.³

Household

It is defined⁴ as “a group of persons who commonly live together and would have their meals from a common kitchen unless the exigencies of work prevent any of them from doing so. There may be a household of persons related by blood or a household of unrelated persons or having a mix of both. Examples of unrelated households are boarding houses, messes, hostels residential hotels, rescue homes, jails, ashrams, etc. These are called institutional households. There may be one member households, two member households or multi-member households. For census purposes, each one of these types is regarded as a household. A household may consist or more than one family while a joint family may consist of more than one household.

Socioeconomic Status

Socioeconomic status (SES) is an important determinant of health and nutritional status as well of morbidity and mortality. The variables that affect socioeconomic status are different in case of urban and rural societies. For example, the influence of caste on social status is very strong in rural communities but not so much in the cities. Separate scales are hence used for measuring the SES in rural and urban areas.

The SES scale (rural) developed by Pareek⁵ attempts to measure the socioeconomic status of a rural family. It is based upon nine items as follows:

1. Caste
2. Occupation of head of family

3. Education of head of family
4. Level of social participation of the head of family
5. Land holding
6. Housing
7. Farm power (drought animals like bullocks, prestige animals like camel, elephant, horse and mechanical power like tractor)
8. Material possessions
9. Family (type of family, family size and distinctive features of family in respect of persons other than the head of family).

The combined score for the nine items is graded to indicate five SES categories (upper, upper middle, lower middle, upper lower, lower).

The socioeconomic status of urban family is assessed by Modified Kuppuswamy scale (**Table 12.2**).⁶ The Kuppuswamy scale proposed in 1976, measures the socioeconomic status of an individual based on three variables like education of head of the family, occupation of the head of the family and total monthly income of that family. Scores have been assigned in each category under these three headings. Ultimately combined score is calculated for grading the socioeconomic status as follows. Of these three variables, education and occupation of the head of the family do not change frequently with time. But, the steady inflation and the resultant devaluation of money demand periodic revision of the income variable. The changes in the income scale are proportional to the change in the Consumer Price Index Numbers for industrial workers CPI (IW). The CPI values are interpreted with reference to a previous base year. This latest updation, that may be applicable in the studies ongoing in 2012, is done using latest Price Index for January, 2012.

The use of SES scales mentioned above is not very common due to several reasons. The most common indicator used for this purpose in most studies is per capita income as suggested by BG Prasad.^{6a} The levels of per capita income initially suggested by Prasad and as recently modified in view of increase in prices are given in **Table 12.3**. BG Prasad's scale is the only scale from which socioeconomic status of both urban and rural families can be determined.

Social Causes of Disease

Causes of disease are often found to operate ultimately at the level of the society rather than an individual. Some examples of such causes are:

- Unhealthy habits of man such as indiscriminate and insanitary defecation, water pollution, drinking, drug abuse, etc.
- Unhealthy customs in families, castes or communities such as *pardah* system, dowry system, child marriage, propitiating gods and goddesses to control

TABLE 12.2: Kuppuswamy socioeconomic scale

Components	Weightage
Education of head of the family	
• Professional degree, postgraduate and above	7
• Bachelors' degree	6
• Intermediate or post high school diploma	5
• High school certificate	4
• Middle school completion	3
• Primary school completion or literate	2
• Illiterate	1
Occupation of head of family	
• Professional	10
• Semi professional	6
• Clerk, shop owner, farm owner, etc.	5
• Skilled worker	4
• Semiskilled worker	3
• Unskilled worker	2
• Unemployed worker	1
Total monthly income (using price index on January 2012)	
• ≥30375	12
• 15188–30374	10
• 11362–15187	6
• 7594–11361	4
• 4556–7593	3
• 1521–4555	2
• ≤1520	1

According to combined scores socioeconomic status is determined as follows:

Socioeconomic status	Scores
• Upper	26–29
• Upper middle	16–25
• Lower middle	11–15
• Upper lower	5–10
• Lower	< 5

diseases, use of “holy” water of Ganga even if it is polluted, beliefs against family planning and immunization, etc. Cultural characters are transmitted from generation to generation and social pathology thus persists. By way of illustration, let us have a look at the problems of low birth weight, anemia in women and high maternal mortality. The physiopathology in these conditions may be diverse and complicated, but a common factor is early marriage among girls. Early girl marriage cannot be eradicated merely by passing laws. This would be a superficial attempt. The Sharda Act prohibiting child marriage was passed

TABLE 12.3: Socioeconomic status as per modified BG Prasad's scale (CPI Rs. 610 July 2011)

Socioeconomic status	Per capita monthly income
Lower	< Rs. 450
Upper lower	450–899
Lower middle	900–1499
Upper middle	1500–2999
Upper class	> 3000

in 1929 and the Child Marriage Restraint Act, last amended in 1978, raised the minimum age at marriage of girls to 18 years. However, a survey conducted a few years ago revealed that one fourth of all married couples in Rajasthan are below 15 years age. For a serious and effective attempt, we must first understand the social causes of the phenomenon of child marriage. Only then can a social diagnosis be made and long-term social therapeutic measures instituted.

Social causes of child marriage are described below⁷:

- The Hindu belief that daughter's marriage is a sacred obligation that the parents must fulfill during their life time (which, in any case, was rather short).
- The belief that the girl's "Bhagya" (good stars) can save the cherished boy from misfortune.
- The arrival of foreign invaders, from whom female population was sought to be protected by early marriage.
- Less expensiveness of marriage functions in case of child marriages, as exemplified by the following: (a) When the eldest daughter in a Rajasthan family reaches 12 years, she is married off along with all younger sisters. The marriage expenses would be much more if each daughter is married separately; (b) Similarly, brothers in a joint family may decide to have a common marriage celebration for all their children. In the like manner, child marriages often take place in large numbers on the same auspicious day in Rajasthan, such as "Akha Teej". This is, again, economical because the number of marriage guests becomes markedly reduced.
- Less dowry demand in case of child brides.
- Less difficulty as regards dowry. Dowry is settled at time of marriage but is handed over only at the time of "gauna" (consummation). This gives time to parents to plan and arrange for dowry.
- If a Rajasthani rural girl does not get married by 12 years, she may never get married to a boy, because none may be available any longer.
- Village girls have often to tend cattle alone in the field, where they are vulnerable to rape. Unlike adult girls, a raped child bride is still acceptable to in-laws.⁷
- Ineffective and defective laws, rules and regulations of local, state or national governments and international bodies. If the government does not provide physical amenities (such as clean water supply, disposal of wastes, housing), does not stop sale of unwholesome food or does not control traffic, there is bound to be ill health and disease. Maldistribution of wealth will affect the health of the poor. Lack of social security provided by the government will affect the health in times of want and old age.

Social Aspects of Treatment

Clinical treatment of any disease with drugs should be logically supplemented with social treatment or therapy as far as possible. When persons having hookworm disease in a community are given mebendazole, the people in the community should also be advised to use latrines and not to go barefooted in the fields. Similarly, treatment of a patient for chronic alcoholism should be supplemented by dealing with social causes which make a person an addict. Maternal and child health depends very much more on social care than medical care. A typical example of social therapy is that of a woman working in a factory who was injured a number of times on the machine. Her injury was treated by the usual dressing each time. Ultimately, the real cause was found to be her anxiety about three children below 6 years of age left at home. They were brought to the creche and she never sustained injury in the factory again.

It is evident that for promotion and protection of health and prevention and control of disease, social environment should be free from harmful agents. Some of the important measures for providing healthy social environment are:

- Social security against fear and want, such as ESI scheme, old age pension, life insurance, provident fund and health and medical facilities or all.
- Fair distribution of food and other amenities of life such as housing.
- Facilities for exercise and leisure.
- Educational facilities for all.
- Propagation of healthy customs such as marriage, monogamy, religious faith, freedom of expression and thought, etc.
- Framing and enforcement of appropriate laws by the government for protection of property, life and honour.

It is in recognition of the importance of social factors in disease that medical social workers are appointed nowadays not only in departments of Preventive and Social Medicine but also in many clinical departments in the hospitals, particularly in leprosy, tuberculosis and STD clinics and in mental and cancer hospitals. A medical social worker is an essential link between the clinic and the home. He makes an investigation of the social factors related to the disease and helps the doctor and the family in dealing with these factors for proper management of the disease. The medical social worker is as important a paramedical person in social medicine as a nurse is in clinical medicine. He or she boosts the morale of the patient and helps him to bear his suffering well. He also helps the patient in getting extra medical facilities such as transport, financial aid, procurement of medicines, rehabilitation, etc. The MSW is an essential member of the team responsible for undertaking a family study, carrying out a social survey, investigating an epidemiological problem or launching a health or disease control program.

The concept of *social defence* is gaining more importance nowadays in relation to multiple social factors responsible for physical, mental and social ill health in the society. Some important areas in need of social defence measures are unemployment, delinquency, alcoholism, drug addiction and child prostitution. If appropriate steps are taken to solve these problems, the health of the society improves not only from a sociological but also from a medical and health management point of view. For example, remedial steps in relation to the above would result in reducing accidents, petty crimes, murders, STD, etc.

Social Environment and Health

So far we have discussed the role of social sciences in health. Some important public health problems related to lifestyle have already been listed at the beginning of this chapter. In order to illustrate further the relation between social factors and health, some concrete examples are given below.

ECONOMIC STATUS AND ROAD ACCIDENTS

Increased prosperity brings in its wake the “time is money” attitude. This results in altered perceptions of the space time economy. For example, a man ordinarily chooses the shortest of the various possible routes to a destination and travels at moderate speed so as to save energy. However, as he becomes richer, his concern shifts from saving petrol to saving time and he prefers to choose a longer route if he can drive on it extra fast. The result is fast driving and, consequently, higher accident rate. One of the reasons for higher road accident rate in Delhi is its higher per capita income, about four times the national average.

SOCIOECONOMIC FORCES AND FAMINE

Dr Amartya Sen, the internationally renowned economist, has established that famines are not caused by lack of food in a country. They are caused by lack of purchasing power in the hands of the poorest. The usual humanitarian urge to rush food to a country in times of crisis is often a failure. This is because several months elapse after the realization that a food crisis exists till the actual food supplies reach the starving people. This time is taken for food aid to be organized and supplies to be loaded, shipped and unloaded. Further inordinate delay causing loss of lives can occur if the country concerned is a dictatorship with news censorship and suppression of free communication. This happened in several African countries during last two decades. In China, during Mao’s Great Leap Forward, 29 million people starved because communist party officials were

afraid to tell Mao the real dimensions of the problem.⁸ Drawing from the experience of several countries, Dr Sen has shown that merely rushing food aid does not suffice to avert a famine. The food thus rushed to the famine hit areas often finds its way back to the prosperous ones, as happened during the Ethiopian famine in 1970’s. Interestingly, per capita availability of food in Maharashtra in 1970’s was no more than in Ethiopia and was less than in Sahel, yet there was, in contrast, no mass starvation. The reason was that while the relief efforts in Africa were confined to free food distribution, those in India used additional innovative approaches in the form of public employment programs which put cash in the hands of the needy. The market forces then operated on their own to move grains to the needy far more efficiently than any government machinery.⁸

CULTURAL PRACTICES AND AIDS

The AIDS epidemic is fast spreading in the world, including India. However, its march in India especially in the early years, was slower than in many other countries. This is partly attributable to the social and cultural practices of the predominant middle class population, which cherishes monogamy as a virtue and frowns upon sexual promiscuity.

SOCIOPOLITICAL FACTORS AND TOBACCO DEATHS

The role of tobacco in causation of cancer (especially that of lung and oral cavity) and cardiovascular disease is well known. Smoking has been labelled as the silent and sure killer. Its prevalence is slowly declining in the West, but is increasing in the developing countries. This is because of social pressures upon the young to smoke (reinforced by high scale multimedia advertising)⁷ coupled with certain political considerations (appeasing the tobacco growers’ lobby, reaping excise and sales tax revenue from cigarettes and protecting vested interests of the cigarette company barons). It may be mentioned that India is the third largest tobacco producer in the world. In the population above 15 years of age in India, the proportion of male and female smokers is 45% and 2.8% respectively with an over all proportion of 51% for those who chew tobacco. WHO observes internationally a “World No Tobacco Day” on 31st fourteenth May each year. The such Day was observed on 31.5.2001. The gravity of the problem is obvious from a World Bank estimate that the net global loss due to tobacco is US \$ 200 billion per year, half of it occurring in the developing countries. The WHO estimates that the number of cigarettes (including bidis) smoked worldwide is 6000 billion per year, amounting, on average, to one thousand

per living human being per year. It is not surprising that more than 3 million people die annually of tobacco related diseases in the world.

HOMELESSNESS

Homelessness has major public health implications for not only those affected but also for the general population. Homeless people are potential reservoirs of infectious diseases like tuberculosis, AIDS, etc. Among the youths it leads to increased crime, substance abuse, etc. Health in homelessness state is compromised by physical environment including hazards of street life, poor nutrition, lack of facilities to maintain personal hygiene and increased risk of communicable diseases through crowding and enforced lifestyle. With the changing social and economic scenario, homelessness is likely to increase.⁹

The Census of India (2001) uses the notion of 'houseless population', defined as persons who are not living in 'census houses' but are in houseless households. Houseless household has been defined as those who do not live in buildings or census houses but live in the open on roadside, pavements, in hume pipes, under

flyovers and staircases, or in open in places of worship, railway platforms, etc.¹⁰

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We have seen in the previous chapter that sociopolitical environment is a crucial determinant of health. An important component of this environment is the legal system. Many laws have been specifically enacted to protect and promote people's health. In addition, the general civil and criminal law can also be invoked to protect the health interests of people. Every physician, especially a community physician, should be aware of such laws. This topic will be briefly discussed in this chapter. Medicolegal aspects related to forensic medicine will not be touched upon.

Poor health in rural areas is essentially a manifestation of their poor resources, bargaining power and access to centers of policy and decision making. To that extent, the discussion of legal aspects of rural health will have to touch upon wider social issues. We shall first have an overview of health laws in general. Then we shall discuss in some detail the legal issues of particular relevance for the rural poor followed by a discussion about how law can be used as a tool to improve health. This will be followed by a discussion on law and the medical profession and, in the end by some thoughts about future legislation.

Laws Related to Health

Merely having a law is not sufficient. What is important is to ensure that the laws enacted are implemented. There is frequent flouting of laws all around, especially in relation to environment, food adulteration and population. As an example of the latter, child marriages are still common.

Health related laws concern three major areas, viz. health care, population and environment. In addition, there are some laws which are not specific to health but have crucial bearing on health issues. Only the more important laws will be discussed. As regards *health care*, the important acts are the Drugs and Cosmetics Act, 1940, Drugs and Magic Remedies (Objectionable Advertisement) Act, 1954, Drugs Control Act, 1956. Indian Medical Council Act, 1956, Medical Degrees Act, 1916, Employees State Insurance Act, 1948 and Indian Factories Act 1948. The *Population Acts* include the Registration of Births and Deaths Act, 1969. The Hindu,

Muslim, Christian and Parsi Marriage and Divorce Acts, the Special Marriage Act, 1954 and the Medical Termination of Pregnancy Act, 1971. The *Environmental Acts*, include Factories Act, 1948, Industries (Development and Regulation) Act, 1951, Mines and Minerals (Regulation and Development) Act, 1947, Prevention of Food Adulteration Act, 1954, Water (Prevention and Control of Pollution) Act, 1974, Air (Prevention and Control of Pollution) Act, 1981, Environmental Protection Act, 1986, and Motor Vehicles Act, 1988. However, another potent legislation affecting health services is essentially a non-health Act, the Consumer Protection Act, 1986 (CPA). This act has been widely welcomed but has also generated controversy as regards its application to the medical profession. The Monopolistic and Restrictive Trade Practices Act, 1969, is another potent law which, though general in nature, can be used for health issues.

Law and the Rural Masses

In the context of the rural people, it is basic inequality between the rural and urban areas that has been perpetuated, both before and after independence. A single example will suffice. Hospital bed availability per 1000 population in urban areas is 16 times that in the rural areas. This is so in spite of the fact that morbidity and mortality is higher in rural areas, underlining the need for better health care facilities there. The adverse doctor population ratio in rural areas, as compared to urban areas, is a reflection of the same trend. As a matter of fact, almost all parameters, including job opportunities and education, housing, communication facilities, etc. show an urban bias.

When social inequity becomes too much, people revolt. However, revolutions often have disastrous effects. It is better to bring change in society through planned legislation rather than unplanned revolution. It needs to be underlined, of course, that legislation by itself cannot bring change. Legislation must be implemented to act as an engine of change. In a democratic system, legislation can be effective only when people are literate and know and demand their rights, as also perform their duties.

Some constitutional and statutory provisions related to health and empowerment of weaker sections are discussed below. Law in relation to old age is discussed in the chapter on Geriatrics.

RIGHT TO HEALTH

Right to health is not specifically listed among the fundamental rights given to every citizen by the constitution of India. However, Article 21 of the Constitution, states “No person shall be deprived of his life or personal liberty except according to the procedure established by law. The Supreme Court, through its judgments, has extended the scope of Article 21. It has read in the right to life several implied fundamental rights like right to clean environment, right to health, right to livelihood, right to education and right to legal aid. The right to health has been recognized by the Supreme Court as a fundamental right under Article 21 in the historic judgment *Consumer Education and Research Centre vs Union of India*.¹ The court laid down in this case certain guidelines to be followed by all asbestos industries.

RIGHT TO EDUCATION

There is no fundamental right to education enshrined in our constitution. But as mentioned in the last paragraph, the Supreme Court has recognized right to education as an implied fundamental right under Article 21. In *Mohini Jain vs State of Karnataka (AIR 1992 SC 1858)* a two judge bench of the Supreme Court held that right to education flows directly from the right to life. This was confirmed by a five judge bench in the *capitation fees Case (Unni Krishnan vs State of Andhra Pradesh, AIR 1993 SC 2178)*, where it was held that this right to education does not extend to all levels of education but is rather limited to free education up to the age of 14 years. It has been felt that rather than have education declared as an implied fundamental right through court judgments, the right to education ought to be specifically declared as a fundamental right by amending the Constitution. The Government has already expressed its willingness to bring a Bill in the Parliament for this purpose.

Needless to say that education is crucial to development of people and improvement of their health. Health status in rural areas is bound to be poor when overall literacy in rural India is only half of that in urban areas. Female literacy, which is even more important, is even lesser. It must be realized that an educated woman is the best bet for containment of population and improvement of health in a community.

CHILD MARRIAGE RESTRAINT ACT, 1929

Marriage of girls at unripe age is a major cause of maternal and pediatric morbidity and mortality. The

Child Marriage Restraint Act, last amended in 1978, raised the minimum age at marriage to 21 for boys and 18 for girls. A decade later, 44 percent married girls in rural areas and 21 percent in urban areas were aged 15-19 years.² There is no legal provision to declare void an early marriage that has been solemnized. Nonlegislation of such a measure reflects a correct and practical approach because the societal good is served not by breaking but by cementing marriages. The Child Marriage Restraint Act is rightly meant to be a preventive measure. What is lacking is its implementation. The proportion of young marriages in rural areas is twice that in the urban areas. This is again related to the rural-urban inequality. Poor educational facilities and higher illiteracy in rural areas inevitably result in perpetuation of old customs, lack of emancipation of women and their exploitation.

BONDED LABOR SYSTEM (ABOLITION) ACT, 1976

Exploitation of poor people held in bondage is a phenomenon whose victims are the helpless rural, especially tribal, people. The Bonded Labor Act has legally banned the practice of bonded labor, but the practice still continues. It will continue as long as the people are not educated and empowered to agitate against it on their own. In this sense the problem of bonded labor is again a reflection of rural-urban inequality. Needless to say, bonded labor is held in virtual confinement and is deprived of basic health facilities. Right against bondage has been held to be an implied fundamental right under Article 21 by the Supreme Court (*Bandhua Mukti Morcha vs Union of India AIR 1984 SC (802)*).

CHILD LABOR (PROTECTION AND REGULATION) ACT, 1986

This act flows from the constitutional directive that “the tender age of children shall not be abused” and that “citizens are not forced by economic necessity to enter avocations unsuited to their age or strength (Article 39)”. However, the Child Labor Act is openly flouted. Fifty thousand children in the carpet industry of Mirzapur (UP) continue to be maimed and afflicted with disease. Depending upon the definition used, the number of working children in India has been variously estimated as 17 million, 44 million and 100 million.² The prevalence is highest in Andhra Pradesh. It goes without saying that the working children are deprived of what every child must have—adequate nutrition, health care, education, family life and play. These children are thus denied health in its widest sense, i.e. in the physical, mental and social dimensions. The vast majority of working children, again, come from a rural background. The solution to the problem of child labour lies basically in rural development, so that the rural-urban inequality is removed.

Other important Acts related to children are the Central Children Act, 1960 and Juvenile Justice (Care and Protection of Children Act 2000).

LAWS RELATED TO WOMEN'S STATUS

No society can develop where women are underprivileged. The key role of women in society has been long realized in ancient Indian culture:

Yatra Naryastu Poojayante, Ramante Tatra Devta
(The place where women are worshipped is the abode of God).

It is in view of this realization that though equality before law is the basis of the Indian constitution, an enabling provision of high potential value has been included in the Constitution in the form of Article 15. Under this Article the state can make special provisions for women and children overriding the general principle of equality for all. Under the directive principles, Article 42 enjoins "the state to make provision for securing just and humane conditions of work and for maternity relief". This has been translated into the Maternity Benefit Act, 1961. The Medical Termination of Pregnancy Act, 1971 is meant to protect the physical and mental health of pregnant women. Prenatal Diagnostic Techniques (Regulation and Prevention of Misuse) Act, 1994 aimed at preventing sex selective abortion, warns the people, in effect, that the life of a female, even an unborn one, cannot be trifled with.

There is a definite reason for detailed discussion of women's status in a chapter on Health and Law. MCH and family planning are major thrust areas in India's health policy and programs. Both these thrust areas directly concern women. Success can be achieved only when women's status is raised to a level at which they are competent to critically analyze their own problems, take appropriate decisions and implement those that they have taken.

Law as a Tool to Improve People's Health

Legislation can serve as a potent tool to improve health. However, a law is just a tool. By itself, it lies buried in the statute books. It has to be used and enforced to be effective. The implication is that citizens must know and demand their rights related to health if they want to have a healthy society. If this is true for a layman, it is much more so for health professionals, especially those with a public health background. This, as a matter of fact, is the main reason for including a Chapter on Law in a Textbook of Preventive and Social Medicine. Having agreed that it is important for all to possess knowledge of health related laws and to claim their health rights, it is unfortunate to note that there are serious shortcomings on both fronts. Some examples are given below to illustrate how the potential of law can be tapped to achieve the aim of health for all.³

Medical Negligence and Inefficacy of Indian Medical Council Act, 1956

This Act lacks teeth as regards punishing doctors guilty of medical negligence. Examples of such negligence are wrong removal of a healthy eye, wrong amputation of healthy limb, transfusing blood of a nonmatching group, leaving behind in the body scissors and sponges used during surgery, etc. As against 20% medical negligence cases in USA going to the Medical Council, the proportion is negligible in India. Even in cases decided against a doctor, the only punishment the MCI can award is deleting the name of the doctor from its register. It has no power to order compensation. The following case illustrates this dramatically. An anesthetist came to the hospital in a drunken state and caused the death of a patient on the operation table. The Karnataka Medical Council simply let him off with a warning while the Mangalore District Consumer Forum awarded damages worth Rs 3.5 lakh against the anesthetist and Rs 1.5 lakh against the surgeon. The scope of consumer movement is discussed below.

CONSUMER PROTECTION ACT, 1986

Consumer Protection Act, 1986, was legislated to provide for better protection of the interests of consumers and to promote and protect their rights. The six consumer rights are right to safety, to be informed, to choose, to be heard, to redress and to consumer education. Under this Act a consumer can seek justice in the consumer court if he or she feels cheated in any of the following ways:

- An unfair trade practice or a restrictive trade practice has been adopted by the trade.
- The goods bought by him suffer from a defect or the services hired or availed of or agreed to be hired or availed of by him suffer from deficiencies in any respect.

The consumer has a right to file his case in the District Forum, State Commission or National Commission, depending on the amount of compensation claimed. He does not have to hire an advocate, and there is no court fee. Only cases claiming compensation more than Rs 20 lakh can be filed directly at the National Commission.

People can be viewed as consumers of medical and health services and can seek compensation under this Act. As an example a consumer court in Orissa ordered a private nursing home to pay rupees one lakh as compensation to a woman who lost the child she was carrying as well as her uterus while under treatment. In this bizarre case, the nursing home was owned by a doctor whose father, an advocate, also tried to pass off as a doctor, prescribing treatment. The name of the advocate was removed by the Orissa Bar Council from its register. The potential outreach of the consumer movement is exemplified by the case Cipollone vs

Liggett in USA, where the cigarette company was ordered to pay damage worth four lakh dollars for their responsibility towards the death of Rose Cipollone, a smoker, attributable to harmful effects of tobacco.³

The CPA comes to easy rescue of the aggrieved consumer because the complainant has neither to pay court fees nor engage lawyers, and the court has to give judgment within a stipulated time. A recent judgment concerns Government ration shops in West Bengal which supplied adulterated rapeseed oil, leading to death of one person and lifelong disability for several others. Ineffective enforcement of the Prevention of Food Adulteration Act was the root cause. The remedy was sought and obtained by invoking the CPA. Complaint to the National Commission in its original jurisdiction brought forth an order (Dec 8, 1989) for the state to pay monthly pension to those rendered ill till declared medically fit and to pay suitable compensation in case of those who died.³

The applicability of the CPA to health and medical services has been hotly debated. This controversy has finally been resolved by the landmark Supreme Court Judgment dated Nov 13, 1995 delivered by a three judge bench of the Supreme Court in the case *Indian Medical Association vs VP Shantha and others*.⁴ The major points in this judgment are as follows:

- Service rendered to a patient by a medical practitioner is covered under Consumer Protection Act except (a) when the service is rendered totally free of charge, (b) when the service is rendered as a contract of personal service and not as a contract for personal service.
- A contract of service implies relationships of master and servant and involves an obligation to obey orders in the work to be performed and as to its mode and manner of performance. On the other hand, a contract for service implies a contract whereby one party undertakes to render services to or for another, in the performance of which he is not subject to detailed direction and control but exercises professional or technical skill and uses his own knowledge and discretion.
- When all or some patients are required to pay charges in a government or nongovernment hospital or nursing home, services rendered to all patients, including those not paying any charges, are to be covered under this Act. Free service would also be service and the recipient a consumer under the Act.
- Where service is provided free to all patients, even though a token amount is paid for registration purpose only, such service is outside the purview of the Act.
- Where service rendered by a medical practitioner is either covered by a medical insurance policy or forms a part of the conditions of service where by the medical expenses are borne by the employer, such service is covered under the Act and the

recipient of such service is a consumer under the Act.

Doctors, represented by the Indian Medical Association, have criticized the above judgment of the Supreme Court under an apprehension that it will make medical care more costly to the poor man. Such criticism is unwarranted for the following reasons:

- It is based merely on an apprehension. The actual quantum of increase in medical charges, if any, has to be assessed before criticizing the same.
- Charitable dispensaries and hospitals rendering free services to all are not covered by the Act.
- Government dispensaries, hospitals and primary health centres, etc. where services are free to all, are outside the purview of the Act.
- Most doctors agree that including medical services within the ambit of the Act will improve the quality of services rendered.
- The judgment is applicable to all medical practitioners, not only to those in the allopathic system. As a result, accountability will be brought in the medical treatment scene in general and the Act will help in checking quackery as also the use of allopathic medicines by non-allopathic practitioners.
- Compelled by the need for collective defensive action against medical negligence suits under the Act, doctors will tend to join the Indian Medical Association in larger numbers. This will bring unity in the profession.
- Due to threat of being sued under the Act, government hospitals will be forced to provide better facilities to hospital staff and patients. This will force the government to raise health budget, which is less than 2% at present, against the WHO recommendation of 10%.
- Since substantial increase in government budgetary allocation may not be forthcoming in near future, government hospitals and dispensaries will be forced to privatise medical care to some extent, in an effort toward income generation. Privatization of medical care is already recommended in the National Health Policy (Para 8). Similarly, there will be increased motivation for health insurance, which is again a part of National Health Policy (Para 16).

M RTP Act, 1969

Health education and information is an important determinant of health practices and status. Conversely, health misinformation is equally undesirable. The Monopolies and Restrictive Trade Practices Act has provision for action against misleading advertisements and claims. This act can be used to prevent false claims in relation to foods, remedies, appliances and procedures. The author (MCG) had an interesting experience in this connection. Ballarpur industries inserted full page color advertisements in national dailies in 1987 to promote

their *Shapola* brand of sunflower oil claiming that it is full of vitamins, minerals and proteins. The author wrote a letter to Times of India, pointing out the falsity of these claims. This brought forth a legal notice from the company demanding fifty lakh rupees in compensation for libel and damage to the company reputation. An official complaint was then lodged with MRTPC. The company stopped the advertisement thereafter.

Drugs and Cosmetics Act, 1940

Impure and substandard drugs are a menace all over the country, more so in rural areas. Such lapses are actionable under the Drugs and Cosmetics Act. An example of the use of this Act is the case of blindness due to eye drops containing steroids, widely used in conjunctivitis.³ Several people suffered blindness in Rajasthan in this manner. An expert committee recommended that the eye drops should carry a warning that their prolonged use can cause blindness due to glaucoma, cataract or fungal infection. The State Drugs Controller did not take any action. Orders to this effect had to be got issued through Rajasthan High Court which gave its judgment on Jan 20, 1989 (DB Civil Writ Petition No 1107/1987).

National Legal Services Day

National Legal Services Day is being celebrated on 9th November, rededicating to ensure equal opportunities and equal justice to all by legal aid through State, District and Taluk Legal services Authorities / Committees across the country. National Legal Services Authority (NALSA) has proposed free legal services to women and children, Labourers, members of SC and ST, Victims of trafficking in human beings, victims of disasters, ethnic violence, flood, drought, earthquake or industrial disaster, persons with disability as per Disabilities Act 1995.⁵

The Prenatal Diagnostic Techniques (PNDT) Act and Rules

The Prenatal Diagnostic Techniques (Regulation and Prevention of Misuse) Act, 1994, was enacted and brought into operation from 1st January, 1996, in order to check female feticide. Initially it was extended to the whole of India except the State of Jammu and Kashmir. Rules have been framed under the Act. This Act prohibits determination and disclosure of the sex of fetus. It also prohibits any advertisements relating to prenatal determination of sex and prescribes punishment for its contravention. The person who contravenes the provisions of this Act is punishable with imprisonment and fine.

Recently, PNDT Act and Rules have been amended keeping in view the emerging technologies for selection of sex before and after conception and problems faced in the working of implementation of the ACT and

certain directions of Honorable Supreme Court after an appeal by an NGO on slow implementation of the Act. These amendments have come into operation with effect from 14th February, 2003.⁶

STRUCTURE AND CONTENT OF THE ACT

It consists of six chapters which defines:

- The establishments that conduct these tests i.e. genetic counselling centres, genetic clinics, genetic laboratories.
- The professionals who could conduct this test i.e. a gynaecologist, medical geneticist and paediatrician.
- The conditions in which this test can be conducted.
- The prerequisites to be fulfilled before conducting these tests.
- The administrative structures that need to be set up for the effective implementation of this Act i.e. the Central Supervisory board and the State Appropriate Authority and Advisory Committee.
- Procedure for registration of the establishments, grounds for cancellation or suspension of registration.
- Offences and Penalties.
- Maintenance of records and power to search and seize records.⁶

The Registration of Births and Deaths Act, 1969

For the purposes of national planning, organising public health and medical activities and developing family planning programs, it is necessary to have adequate and accurate data of registration of births and deaths throughout the country. To achieve this objective and in order to develop a uniform system of registration throughout the country the registration of Births and Deaths Bill, was introduced in 1967 and it came on the Statute Book as The Registration of Births and Deaths Act, 1969. Birth and deaths to be registered within 14 days and 7 days respectively. Any birth is registered after the expiry date and within 30 days of its occurrence, shall be registered with late fees. Any birth or death registered beyond 30 days but within 1 shall be registered only by written permission from the prescribed authority and on payment of prescribed fee. Any birth or death which has not been registered within 1 year, shall be registered only on an order made by a magistrate of the first class or a Presidency magistrate and on payment of prescribed fee.⁷

Law of Tort

The word 'tort' is derived from the Latin 'tortum' which means 'to twist'. Tortious conduct hence means a conduct that is twisted, crooked or unlawful. There is no codified legislation in the area of tort. The whole tort law is based upon case law, i.e. cases decided by courts. However, as defined in section 2(m) of Limitation Act,

1963, 'Tort means a civil wrong which is not exclusively a breach of contract or breach of trust'. The law of tort is well developed in England, but not much in India. One of the reasons in that people are tolerant of wrongful conduct and hesitate to bring action in a court of law. However, tort provides an avenue for bringing action against negligence in health and medical services.

Medical negligence is an important area in law of torts. When a doctor is consulted by a patient, the doctor owes him certain duties. These duties are (i) duty of care in deciding whether to undertake the case, (ii) duty of care in deciding what treatment to give, and (iii) duty of care in the administration of that treatment. A breach of any of these three duties gives to the patient a right of action for negligence.

In view of the above, the question arises as to what is the test of reasonable standard of care. This question has been answered in the famous case *Bolam vs Friern Hospital Management Committee* (1957) 2 All England Reporter, 118. The test is the standard of the ordinary skilled man exercising and professing to have that special skill. In the case of a medical man, negligence means failure to act in accordance with the standards of reasonably competent medical men at the time". An example of medical negligence is *Dr Lakshman Balkrishna Joshi vs Dr Trimbak Bapu Godbole* (AIR 1969, SC 128). Here the appellant did not give anesthesia to the patient, a 20 years old boy with fracture leg. Only morphine was given and three men pulled the leg for orthopedic manipulation. As a result of excruciating pain the patient went into shock and died. The doctor was held guilty of negligence.

Public Interest Litigation (PIL)

This term was used for the first time by the Supreme Court in the case *Fertilizer Corporation Kamagar Union vs Union of India*. Several innovations were made in relation to the concept of PIL. One of these was that the old Anglo-Saxon concept of locus standi was given up. As per this concept, only the aggrieved party could approach the Court for justice. Under the PIL concept any person can move the Court in the interest of a weak individual or group, who may not be in a position to seek legal remedy on his own. An excellent example is the *Bandhua Mukti Morcha* case filed by a group of social activists which led to release of bonded laborers, mostly from rural areas. A second innovation was that even a letter sent to the Supreme Court on a postcard by the suffering individual was treated as a writ petition. The famous example is the *Sunil Batra* case. He, himself a prisoner, wrote a letter to the Supreme Court alleging use of third degree methods by the jail warden against an under trial. The result was a Supreme Court judgment about jail reforms of far reaching consequence. The purpose of quoting these examples here is that the village people and their support groups

can use these avenues to improve the health status of the rural masses. Two landmark judgements can be quoted in these regard. First is *Municipal Council of Ratlam vs Vardhichand*, decided by the Supreme Court in early eighties.⁸ Brief facts are that residents of a locality moved the magistrate under Section 133 of Cr PC. They complained of foul stench due to open drains and open defecation by slum dwellers and requested that the municipality be asked to do its duty towards citizens by removing the nuisance. The magistrate ordered the municipality to draft an appropriate plan for this within six months. In appeal, the Sessions Court reversed the order. In further appeal, the magistrate's order was upheld by the High Court and Supreme Court, turning down the plea of financial stringency put forward by the municipality. The second case is that of the *Kanpur tanneries*, which discharged toxic effluents into river Ganga. The Supreme Court, in its historic judgment dated Sept 27, 1987, ordered their closure, observing that tanneries which claimed that they had no money to establish primary treatment plants cannot be allowed to exist just as an industry must close down if it cannot pay minimum wages to its workers.⁹

Public interest litigation ought to be encouraged, since it aims at empowering the people, which is a prerequisite for Health for all. The responsibility for this lies on all socially minded persons, especially the health professionals. Doctors have no reason to be afraid of public interest litigation and Consumer Protection Act. Ultimately, such litigation may well result in the state monolith being ordered by the courts to galvanize itself and improve the health care infrastructure.⁹

Detailed information on population laws. A detailed treatise on Health and Law has recently been published child health laws, women's health laws, occupational health laws, food laws and environmental laws, etc. can be obtained from the author's recent book titled "Health and Laws".¹⁰

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The state of health or disease is the end result of interactions that occur in the environment between the agent and the host (man). The role of various environmental factors has already been discussed in the chapters on “Environment”. The role of host factors that help in the promotion and maintenance of health and in prevention and defence against disease is described in this chapter.

The host factors that influence health can be grouped as follows:

- Age, sex, marital status, parity and race
- Physical state of the body
- Psychological state and personality
- Genetic constitution
- Defense mechanisms
- Nutritional status
- Habits and lifestyle.

Age, Sex, Marital Status and Race

Age and Sex

Infectious diseases like measles, whooping cough and nutritional deficiencies are common in childhood, cancer and venereal disease in middle age and arteriosclerosis and coronary heart disease in old age. However, an increasing trend towards early occurrence of coronary disease has been found during the last few decades. Certain neoplastic diseases like leukemia, breast cancer and Hodgkin's disease show bimodal age incidence, indicating thereby that two different sets of factors may be operative in their causation. For example, Hodgkin's disease shows one peak at 15 to 35 years and another beyond 50 years.¹ Chromosomal anomalies like Down's syndrome are more common in the offspring of women conceiving after 35 years of age. Women in general have higher longevity than man. Certain diseases are exclusive to males and females. Examples are cancer of prostate and testes and cancer of breast and cervix. Some diseases are more common in men (atherosclerosis, coronary heart disease, lung cancer) while others are more common in women (obesity, diabetes mellitus, hyperthyroidism). A few diseases show difference in severity between the two sexes. Thus syphilis is more severe in males, probably because of anatomical and hormonal differences.

An aspect of sexuality getting particular attention these days is sexual orientation, earlier referred to as sexual preference, in relation to homosexuality or heterosexuality. There appears to be a genetic basis for sexual orientation. It may be mentioned that gays are more prone to get certain infections, including HIV infection.

Sex differences in disease may have a cultural basis. For example, Chutta cancer (cancer of hard palate caused by reverse smoking, i.e. smoking a cigar with the lighted end in the mouth) is more common in women in Andhra Pradesh. The reason is that reverse smoking is used by women as a mark of respect to men with the result that 36 percent women compared to 20 percent men use this technique.^{1a}

Marital Status and Parity

Cancer of cervix is rare in nuns and far more common in married women. Gallstones disease is classically described to be common in fat, fertile females. Obesity in women is similarly common in those who are multiparous. On the other hand, breast cancer and cancer of the body of uterus are more common in multiparous women.

Marital status is well known to affect lifespan. According to a Soviet study,² staying single can cut short a man's lifespan by more than nine years and a woman's lifespan by more than four years. This does provide scientific justification for men marrying in old age.

Race

Racial or ethnic differences are combined manifestations of genetic and environmental factors to which a population is exposed. Thus some races have innate resistance to malaria, syphilis, tuberculosis, leprosy and perhaps to AIDS (Acquired Immune Deficiency Syndrome) infection. As an example, it may be mentioned that acne vulgaris, so common among caucasians, is uncommon in blacks and rare in the Japanese. Parsis have a higher incidence of G-6-PD deficiency.

Physical State of the Body

Fasting, fatigue and cold, lower the body resistance against disease agents. On the other hand, a well fed person with adequate rest and clothing is less prone to fall ill. For example, acute respiratory infections are more common

during the winter season. Similarly, persons with inadequate clothing during cold climate fall sick more often.

Psychological State and Personality

Compulsive habits, behavior pattern and personality traits influence the human health to a great extent. Indulgence in overeating, smoking, alcoholism, drug addiction, promiscuity, etc. leads to various related diseases. Too much worry and mental tension is associated with psychosomatic conditions like hypertension, coronary disease, peptic ulcer, etc. A careful and conscientious person will ward off many accidents and infections and will prevent exposure to harmful chemicals. On the other hand, a person with an accident prone personality runs an increased risk to health. The details of mental health are further discussed in Chapter 34.

Recent research has revealed some newer mechanisms by which psychological state can act as a host factor influencing health. There is evidence that a state of complete mental relaxation, as found in meditation and certain yogic asanas such as shavasana, is associated with increased alpha wave activity in frontal lobes and a positive effect on immune defense mechanism of the body.

The 1980's saw the birth of a new discipline called psychoneuroimmunology (PNI). It studies interactions between brain, behavior and the immune system. It grew from the realization that the central nervous system and the immune system are intricately interlinked and have subtle interactions. PNI offers an explanation for the well known placebo effect and its newly named counterpart, the so called nocebo effect. The placebo effect—patients recovering from their illness because they believe they will—has been known for a long time. The nocebo effect patients falling ill because they believe they will—has also been well known, though not named earlier as such. A classical example is an asthma patient allergic to rose pollen developing an attack merely on being presented a paper rose. Another example is the well known “white coat hypertension”—a rise in blood pressure when in a doctor's clinic.^{2a}

Genetic Constitution

Genetic factors play an important role in predisposition towards disease or resistance against it. Hereditary defects, transmitted through genes, may be present at birth or may manifest later in life (e.g. Huntington's chorea, Friedreich's ataxia). These may be transmitted through many generations, such as harelip and polydactylism. It should be noted that the term ‘congenital’ is not synonymous with ‘hereditary’. The term birth defect simply refers to the fact that the defect is present

at birth. *Nongenetic Birth Defects* are due to conditions related to the mother or the birth process. For example, intrauterine infections like syphilis, rubella and toxoplasmosis may be transmitted to the fetus from the mother. Ingestion of some drugs by the mother during pregnancy may disrupt fetal development. Fetal malposition, difficult delivery and bad management during labour may result in birth injuries. Gonococcal infection contracted during passage through birth canal may be responsible for ophthalmia neonatorum. *Genetic Birth Defects* may occur through three mechanisms.

- 1. Chromosomal disorders:** Wherein the chromosomes are abnormal in number or structure, e.g. Down's syndrome (trisomy 21). Turner syndrome and fragileX-mental retardation.
- 2. Single gene disorders:** Which result from abnormalities of single genes. More than 4300 monogenic disorders in human being have been identified so far.
- 3. Multifactorial disorders:** Where several genes interact with multiple exogenous or environmental factors to cause disease. Many of such disorders are said to run in families but the inheritance pattern is complex. Examples are diabetes mellitus, gout, cleft lip, cleft palate, coronary heart disease, etc.

It is sometimes difficult to clearly differentiate the effect of genetic and environmental factors upon the human host. As an example may be mentioned the health and disease differentials in higher social classes versus lower socioeconomic groups. These may also be acting via genetic and constitutional factors of the host in addition to the environmental factors. Human genetics is slowly emerging as an important element in the control of disease since it may facilitate the differentiation of those individuals who are susceptible to infection or prone to noncommunicable disease from those who are not. An example is afforded by two recent discoveries around 1995-96. One of these refers to identification of a gene that determines personality. The other is the discovery of three genes in Indians not found in any other race worldwide. These belong to the DR2 group of genes and are associated with proneness to suffer from leprosy, tuberculosis and certain types of cancer.

Inheritance and Expression of Genes

Genotype refers to the genetic constitution. The genetic constitution indicates what genes a particular person has inherited from the parents. *Phenotype* is the outward expression or manifestation of the genetic character such as tallness or dwarfness. The common blood groups have four phenotypes A, B, AB and O depending upon the presence of A or B agglutinogens in the blood. The corresponding genotypes of these blood groups are AA or AO, BB or BO, AB and OO.

Similarly color, height, weight, vision, etc. are phenotypic characters expressed by respective genetic constitution. Phenotype characters like weight and blood pressure may be influenced by environment but also depend upon genotypic constitution. Thus the genotype is fixed for an individual while the phenotype is subject to environmental influences.

Nontransmission or Abnormal Transmission of Characters

Genetic transmission of characters from one generation to the next may be altered because of chromosomal aberrations or mutations. An example of chromosomal abnormality is Down's syndrome or Trisomy-21, which, in 95% cases, is due to nondysjunction during meiosis. Common examples of genetic mutations are sickle cell hemoglobinopathy and G-6-PD deficiency. The causes of mutation under natural conditions are not known. The great majority of mutations, at least those producing a marked or easily observable effect, are harmful. Genetic mutations also play a part in evolution.

Application of Genetic Principles in Preventive Medicine

HEALTH PROMOTION

Improvement of health of the people by applying the principles of genetics comes under the domain of eugenics. It is the study and control of factors in the parents which affect the hereditary qualities of the future generation.

In order to improve the health of the race and to prevent hereditary diseases, the following measures should be undertaken:

- *Marriage guidance and genetic counseling at the family welfare clinics:* The aims should be:
 - To ensure that both the partners have good health and there is no history of adverse hereditary traits.
 - To discourage inbreeding or endogamy so as to avoid mating of heterozygotes present in a family tree. Such heterozygote mating is more likely to produce homozygotes with phenotypic expression of the recessive character. The obvious example is that of thalassemia which is fairly common in some communities. Here it is advisable that the heterozygotes who have thalassemia should not intermarry.
 - To advise whether next child should be produced or not when a recessive gene has appeared in one child.
- *Restriction of conception in women aged above 35 years through birth control methods.*
- *Taking precautions against exposure to radioactivity which can damage germ cells.*

SPECIFIC PROTECTION

A classical example of the use of genetic principles in preventive medicine is the prevention of blood group incompatibility. The blood group in the ABO system depends upon the presence of A and B agglutinogens. Persons with O group have none while those with group AB have both. A and B agglutinogens induce production of agglutinins which agglutinate RBCs of the recipient. These are inherited in a simple Mendelian manner, with the result that the child will have specific antigen if one of the parents had it. There are many other hemagglutinogens in human blood of which Rh factor is the most well known. If the mother is Rh negative and the embryo is Rh positive (because of the father), the mother will develop antibodies against the Rh positive fetal blood. These antibodies can get across the placenta and destroy fetal red cells, resulting in erythroblastosis neonatorum in the newborn. In this condition the child has hemolysis and jaundice and death may occur. An Rh negative mother should have the Rh status of the husband tested. If he is Rh positive, the Rh antibody levels in the mother should be determined during pregnancy. Expectant mothers are now routinely tested for Rh negativity in antenatal clinics.

Examples of other genetically transmitted diseases are retinitis pigmentosa, progressive muscular dystrophies and Cooley's anemia (thalassemia major). It may be advisable not to marry or to produce children in such cases. If the disease is due to a fully dominant gene, the probability of the child inheriting it is 50%. If it is due to a fully recessive gene the child will get the disease only if both parents are homozygous for the gene. Heterozygotes will be detected only if they have already produced one defective child. Hemophilia is due to a recessive sex linked gene transmitted by normal mothers to male children. Girls from such families should not have children.

EARLY DIAGNOSIS AND TREATMENT

The role of the agent, host and environmental factors is well understood in communicable diseases and the adoption of specific measures is easy. In many non-communicable diseases where current knowledge is not adequate, such as essential hypertension and atherosclerosis, genetic factors often play an important role. Though genetic transmission may be difficult to prevent, early detection of genetic defects can help in taking appropriate measures to prevent or reduce the phenotypic expression of the genotype. Once a person is diagnosed to have a genetic disorder, his entire family group and pertinent relatives should be screened to detect the disease trait. Early detection is facilitated by antenatal ultrasound examination, biochemical and cytological analysis of amniotic fluid for markers of congenital defects and inborn errors

of metabolism. Newer techniques have now made it possible to look for mutated genes in blood samples. These gene increase the possibility of an individual developing cancer of the breast, colon and thyroid, among others. In case of melanoma, the concerned gene can be detected in swabbings from buccal mucosa. Such tests have already become commercially available in USA.

A few examples of early diagnosis are given below:

- Abnormally high uric acid level (uricemia) due to disturbance of purine metabolism may be found in the relatives, parents and sibs of a patient with gout.
- A high proportion of sibs of a diabetes patient show impaired glucose tolerance.
- Sibs of coronary patients show high serum cholesterol levels due to disordered cholesterol or lipid metabolism.
- Coronary disease is found more frequently when there is coincident hereditary tendency for hypercholesterolemia and hyperuricemia.

Early diagnosis can help in prolonging or even saving life by instituting appropriate medical or surgical treatment. An example of surgical treatment is removal of spleen in essential thrombocytopenic purpura. Medical treatment may be of two types. First, the protein missing due to a genetic defect may be supplied, such as insulin in diabetes, gamma globulin in congenital agammaglobulinemia and hemoglobin (in the form of repeated blood transfusion) in beta thalassaemia. Second, appropriate diet control may be enforced so as to eliminate intake or formation of a substrate that cannot be metabolized due to the missing enzyme, as explained below in the context of disability limitation.

DISABILITY LIMITATION

Even though genetic diseases may not be amenable to permanent cure at present, much can be done to limit the disability caused by them. Mental deficiency in children with phenylketonuria (PKU) can be prevented to a large extent if they are kept on a low phenylalanine diet from the very beginning. The progress of disease can be considerably halted by appropriate therapeutic and preventive measures in patients with hemophilia, thalassemia, sickle cell disease and G-6-PD deficiency.

REHABILITATION

Even though therapeutic measures may not be available or effective, much can still be done to rehabilitate patients with genetic diseases, like muscular dystrophy, Friedreich's ataxia, juvenile amaurotic idiocy, phenylketonuria and retinitis pigmentosa. These patients can be provided aids and taught skills that might facilitate their psychomotor function and increase their capacity for self sufficiency.

Defense Mechanisms

The different tiers of body defense are³ physical and chemical barriers, primary or innate defense mechanisms (inflammatory response and phagocytosis) and adaptive immunity.

Physical and Chemical Barriers

The body is endowed with a thick horny layer of skin to protect it against the pathogens in the environment. It is not easy for the microbes to successfully pierce through it. Also, the fatty acids in serum have bactericidal properties. Similarly, the mucosal linings of the gastrointestinal, respiratory and genitourinary tract protect against and prevent the entry of disease producing microbes. The lysozymes in saliva and tears and the extreme pH of gastric and intestinal fluids also protect the body against the entry of pathogenes. In addition to the body's intrinsic barriers, the normal commensal microbes play an important role in protecting the body against invading pathogens. For example:

- Antibiotic suppression of normal gut flora predisposes³ to oropharyngeal or perianal candidiasis and to prolongation of *Salmonella* carrier state;
- Doderlein's bacillus (probably same as *Lactobacillus acidophilus*) in vagina helps to maintain a low vaginal pH around 4.5 at which most other bacteria cannot grow
- Salivary streptococci in mouth protect against pathogens by producing hydrogen peroxide.⁴

Innate Defense Mechanisms

In situations, where the above mentioned physical and chemical barriers are successfully pierced by an infectious agent and the pathogen has entered the tissue, the next line of defense, the 'primary or innate' resistance mechanisms, comes into play. Thus the polymorphonuclear leukocytes, tissue macrophages and other phagocytic cells immediately come into action and try to engulf and destroy the invading pathogen. Side by side, there evolves a basic tissue reaction called "inflammation". This leads to the outpouring of a huge number of opsonins and other humoral substances in the area being invaded by the pathogen. In addition to this, the inflammatory reaction also causes chemotactic attraction of more phagocytic cells in the local area to deal with the remaining pathogens.

Adaptive Immunity

In the majority of the ordinary circumstances the above mentioned mechanisms suffice in the control of infections. However, if the pathogen is very resistant, the two above mentioned lines of defence may not be

sufficient. To tackle such microbes, the body has evolved an adaptive defense system in the body called “the immune system.” This system consists of lymphocytes and lymphoid organs of the body. The basic principles of its functioning are “specificity” and “memory.” This system specifically recognizes the pathogen, reacts against it and develops memory for future reference. Thus it adapts itself to any future contact with the same pathogen. If a repeat contact does take place, the immune system launches a vigorous and very efficient specific immune response against that pathogen, killing and destroying it with ease. This phenomenon is called active immunity, (as contrasted to passive immunity).

The immune system broadly consists of:

- Cellular components (lymphocytes and macrophages)
- Immunoglobulins and
- Complement system.

Among the cellular components, the lymphocytes are of two major types—T-lymphocytes and B-lymphocytes. The T-lymphocytes are those that are dependent for their maturation upon a hormonal factor produced in the thymus. The B-lymphocytes are similarly dependent for their maturity upon the bursa of Fabricius in birds (the nearest equivalent of which in man are the tonsils and the gut lymphoid tissue). T-lymphocytes are largely responsible for cell mediated immunity. B-lymphocytes are responsible for the synthesis of humoral antibodies. These antibodies or immunoglobulins are of five types. The main antibody is IgG which comprises 73 percent of the serum immunoglobulins and is distributed equally between blood and interstitial fluids. IgG is the only immunoglobulin that passes across the placenta and thus provides passive immunity to the infant against diphtheria, tetanus, etc. during the early months of life. IgA accounts for 19 percent of serum immunoglobulins and is principally secreted into colostrum, saliva, intestinal juice and respiratory secretions.⁵ It plays a major role in preventing infection by enteroviruses, including poliomyelitis. IgM and IgD have no well defined roles. The IgE (reaginic antibody) constitutes an integral part of immediate hypersensitivity reactions and possibly plays a role in defence against helminths.⁵ The complement system, which is fairly complicated, has a major role in prevention against infectious diseases.

Principles of Immunization

In the process of immunization the body’s immune system is actively stimulated by the antigen used for immunization. This leads to the production of specific antibody (humoral immune response) or specifically sensitized cells (cell mediated immune response), which specifically combine or react with the pathogens and destroy them. The immunization procedure which

causes active stimulation or production of specific antibodies is called *active immunization*. On the other hand, transfer of readymade antibodies from an actively immunized animal or human being to another is called *passive immunization*. Active immunization can be used in the prevention of various infectious diseases. But active immunization takes upto three to four weeks and, sometimes, a series of injections before protective levels of immunity can be attained. Obviously, it is not useful when protection is required within a short period of a few hours or days. In such situations (e.g. dog bite, snake bite, established diphtheria or tetanus, prick of a needle infected from a hepatitis patient), passive immunization is the only protective and preventive procedure possible.

Host defense mechanism may be impaired in immunodeficiency states which may be congenital or acquired. The latter may be due to AIDS, radiotherapy or use of cytotoxic drugs. In such situations, a mixture of serum gamma globulins (which contain antibodies normally found in adult serum) are repeatedly injected in the body to keep the gamma globulin levels within a desirable range. Such attempts are particularly aimed at prevention from rubella, poliomyelitis and viral hepatitis.

Nutritional Status

Impairment of nutritional status of the host is almost synonymous with impairment of the capacity of the body to fight disease. Malnutrition and infection, in fact, form a vicious circle, whereby malnutrition predisposes to infection and infection aggravates malnutrition (**Fig. 14.1**). The mechanisms involved are explained in **Tables 14.1 and 14.2**. A recent review of nutrition in relation to leprosy shows that leprosy infection results in lowering of vitamin A, vitamin E and zinc nutritional status, but an increase in serum copper levels. The changes are more marked in lepromatous than in tuberculoid leprosy.^{5a}

The effect of nutritional status of the host upon his capacity to fight disease is discussed in detail in the chapter on Food and Nutrition. However, it is appro-

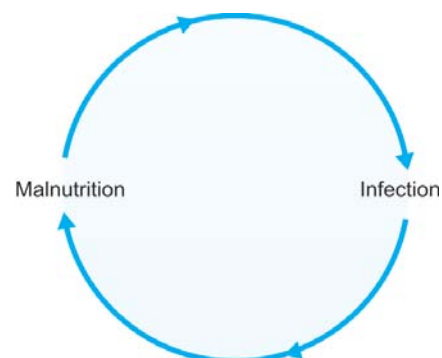


Fig. 14.1: Relationship between nutrition and infection

TABLE 14.1: How infection results in malnutrition?

- *Reduced food intake*
 - Decreased appetite
 - Altered sensory perception
 - General malaise
- *Reduced nutrient absorption*
- *Increased caloric expenditure*
- *Utilization of glucose in preference to fatty acid as source energy*
 - Increased gluconeogenesis Negative
 - Decreased synthesis of muscle protein nitrogen
 - Decreased albumin synthesis balance
- *Hypovitaminosis*

TABLE 14.2: How malnutrition aggravates infection?

- *Mechanisms involved*
 - Increased predisposition to and severity of infection impaired tissue integrity
 - Impaired immune response (cellular as well as humoral)
 - Endocrine and metabolic effects
- *Effects of specific deficiencies*
 - *Protein deficiency*: Synergistic with all bacterial infections including tuberculosis. Helminthic infections more severe in protein deficient animals.
 - *Vitamin C deficiency*: Synergistic with almost all infections studied.
 - *Vitamin A deficiency*: Synergistic with many bacterial diseases, also with several helminthic infections in animals.
 - *Energy deficiency*: Synergistic with infections in general.

appropriate to discuss here the effect of host nutrition upon host immunity.

Nutrition and Immune Response

Recent studies have shown that the immune system, like other systems in the body, also shows malfunction in persons with malnutrition. Thus in mild and borderline malnutrition, cell mediated immunity is decreased to some extent. It is usually compensated by humoral immunity with consequent increase in serum gamma globulin levels. In moderately severe malnutrition, even the humoral immunity is decreased and the capacity to produce antibody goes down. In the most severe forms of malnutrition, even the primitive body functions like phagocytosis and inflammatory response are decreased. Recent studies have shown the importance of trace elements in immune response. Thus, even mild to moderate zinc deficiency may lead to profound malfunction of the immune system of the body. A recent review suggests that zinc deficiency may facilitate occurrence of leprosy through impairment of the immune response.^{5b} It is obvious that malnourished individuals show increased susceptibility and response to infections because of depressed functioning of the immune system. This leads to further malnutrition, thus starting a vicious cycle (**Fig. 14.1**). There is also evidence that the “take” of immunization is decreased in malnourished persons because of depressed immune function.³

Habits and Lifestyle

While community health is the concern of the state, the health of an individual is his own responsibility. The government can only ensure that all individuals have access to adequate food, clothing, shelter, immunization facilities and treatment for disease. But no government can force the people either to use these facilities or not to indulge in practices injurious to health. Herein lies the importance of lifestyle and healthy habits, including personal hygiene. In course of time hygienic and healthy habits become a natural way of life and thus help to maintain life-long health.

In a narrow sense, the term personal hygiene implies observance of personal body cleanliness. In a wider sense, it implies the observance of healthy practices by an individual in his daily life.

Healthy Habits

ORAL HYGIENE

Eat some fibrous fruit or vegetable (such as apple, orange, carrot, salad) at the end of a meal. This helps in proper cleaning of teeth. Refined sugar is not good for teeth. Drinking water should contain at least one PPM of fluorine as prophylactic against carries. Rinse the mouth well after eating something. Use a good quality tooth brush. Any tooth paste or tooth powder is good enough for use. However, the powder should not be too coarse. Teeth must be brushed before retiring for the night. Visit a dentist regularly.

DIGESTIVE SYSTEM

- Do not eat in a hurry and under stress or worry. Chew the food well.
- Do not eat too much sugar and fat.
- Fasting is good for all ages. It gives rest to stomach when there is indigestion. It also helps build up will power and thus contributes to sound mental health.
- Take meals at regular timings. The interval between two meals should not be unduly long, especially in case of infants and children.
- Eat enough vegetables and fruits.

RESPIRATORY SYSTEM

Ventilate the lungs well with deep breathing exercises. Avoid chills, dust, irritating fumes and overcrowding. Do not smoke and avoid passive smoking.

CIRCULATORY SYSTEM

Avoid coronary risk factors like smoking, overweight, mental tension and excessive intake of salt and cholesterol. Take daily physical exercise. Get blood pressure checked at least once a year after 40 years of age.

EYES

Eyes should be kept clean and well protected from dust and irritating atmosphere. Errors of refraction should be corrected. While reading a book, it should be kept at a distance of about 30 cm from the eyes. The light should be adequate and should preferably come from the left. Do not read in a running vehicle. Do not look directly at the sun, are light or solar eclipse, otherwise retinal burns may be caused. It is advisable to perform ocular convergence exercises daily for four to five minutes. This is done by holding the hand in front of the eyes, fixing the gaze at the tip of the index finger and moving the finger slowly towards the face to ultimately touch the nose, keeping the gaze fixed at the tip of the finger unless one sees two fingers for one. Then slowly take away the finger and fully stretch the hand as earlier. Repeat the process eight to ten times at each sitting daily. With some practice, it should be possible for the finger tip to touch the nose without the occurrence of diplopia.

NERVOUS SYSTEM

Avoid use of addictive narcotic substances such as alcohol, opium, cocaine, cannabis, nicotine and tobacco. Use tea, coffee and cocoa in moderation. Minimize worries, mental strain and overwork.

Lifestyle

Lifestyle has emerged during last two decades as a major modifiable determinant of health and disease. The peculiarity of this determinant is that control mechanisms have to be applied not in the external environment but within one's internal mental domain. As such, the adoption of a particular lifestyle is a direct reflection of inner control or will power. It is in this context that spirituality is also included in the seven major components of lifestyle from the point of view of health as listed below:

1. Dietary intake, including beverages like tea and coffee (discussed in Chapter 22)
2. Alcohol intake (discussed in Chapter 34)
3. Drug addiction (discussed in Chapter 34)
4. Smoking
5. Sexual behavior
6. Physical fitness and exercise
7. Spirituality

Only the last four aspects will be discussed here.

SMOKING

Smoking is a pernicious scourge of the world today. According to data from USA, smoking is number one cause of premature death. It kills more people every year than alcohol, heroin, cocaine, homicide, suicide and AIDS combined.⁶ It is reported that one million Indians (0.1% of total population) die every year from tobacco related diseases including smoking and chewing

of tobacco.^{6a} In France also, about 0.1% population dies annually due to smoking. Out of the 58000 smoking related deaths in France in 1985, 29000 (50%) were due to cancer, 17,500 (30%) due to cardiovascular illness and 7,000 (12%) due to chronic respiratory illness.⁷ Data from India on similar lines is not available, but is likely to reflect the same trend.

Smoking a cigarette means inhaling about 1.7 mg nicotine and about 20 mg tar. The former causes addiction while the latter causes cancer. Besides cancer, there are several other harmful effects. Statistically significant association between smoking and development of pulmonary tuberculosis has been reported.^{7a} Smoking affects all body systems adversely including the nervous, gastrointestinal and reproductive systems. Even the skin is affected: blood flow to skin decreases due to smoking, causing early wrinkling. As regards reproductive system, the effects are quite obvious in case of women smokers. Smoking during pregnancy causes low birth weight and fetal death. Smoking also decreases the movement in the fallopian tubes, increasing the risk of ectopic pregnancy and infertility. It is also related to an increased risk for cervical cancer due to interaction of the cancer causing agents in tobacco smoke with the HPV virus. The other well known problem for women who smoke is the interaction with oral contraceptives in increasing the risk of heart disease. Women who are over 35 years who smoke and take the pill are much more likely to have a fatal heart attack than women of same age who do not smoke and do not take the pill.⁶

If tobacco smoking is to be minimized as a host factor, it involves two types of actions on the part of the human host.

Avoiding active smoking: Starting or stopping smoking is a personal decision which depends on several factors besides enjoyment derived from cigarettes. For example, about half the smokers smoke even when they do not enjoy doing so.^{7b} The health professionals can help in dissuading people from starting smoking and encouraging smokers to stop doing so. Research in USA shows that 5 to 20 percent patients who quit smoking are advised to do so by their doctor. According to a recent survey,^{7c} one third Indian smokers tend to consult their family physician for problems arising out of smoking. The responsibility of the medical profession in this direction is obvious. The antismoking campaign has already started showing results in USA. Between 1976 and 1987, the number of adult male smokers dropped by nine percent. The decrease in case of women was only four percent. Unfortunately, more women than men are taking to smoking in USA at present. It is feared that if this trend continues, women smokers will outnumber men in USA by mid-nineties.⁶

Avoiding passive smoking: Passive or involuntary smoking has been recognized as a definite health hazard. A passive smoker is a person who is exposed

to tobacco smoke exhaled by a smoker in the vicinity. Common situations are home, work place, cinema halls and public transport. Some examples of the damage caused by passive smoking are given below.⁸

- According to a report from the National Academy of Sciences, 3,800 lung cancer deaths in USA, representing three percent of total lung cancer deaths, were attributable to passive smoking.⁸
- Nonsmoking wives of smoking husbands have 30 percent higher risk of lung cancer compared to wives of nonsmokers. This risk is multiplied seven to ten times when the husbands are heavy smokers.
- Nonsmokers exposed to 20 or more cigarettes a day at home have twice the risk of developing lung cancer compared to those not so exposed.
- Children of smokers have greater chance of developing colds, bronchitis, pneumonia, chronic cough, ear infections and impaired lung function.

It may be mentioned that there has been worrisome increase in female smoking recently. Out of 200 million women smokers in the world today, 100 million are in developed and 100 million in develop countries. This means 21 percent women in develop countries and 8 percent in developing countries smoke. As a matter of fact, half of the adolescent boys or girls, who start smoking and continue with it throughout life, will be killed by tobacco. Putting it bluntly, women who smoke like men will die like men.^{8a}

SEXUAL BEHAVIOR

Sex is a very personal affair. It is one area which is related to health, yet advice about which is usually avoided. Some examples of sexual behavior affecting the health of the human host are given below.

- Sexual promiscuity with several partners is conducive to contracting venereal diseases including AIDS.
- Sex without contraception results in unwanted pregnancy, with all its sociological, psychological and physiological implications.
- Male homosexuals are at higher risk of AIDS.
- Masturbation, along with guilt feeling, is a cause of much anxiety in most adolescents.
- Rape and child abuse are manifestations of uncontrolled sexual behavior.
- Extramarital affairs often lead to mental tension, violence, suicide and homicide.
- The ultimate cause of septic abortions, associated with much maternal morbidity and mortality, is uncontrolled sexual behavior.

PHYSICAL FITNESS AND EXERCISE

A certain amount of physical exercise is essential for keeping the body fit. The advantages of a fitness regime go beyond the physical domain. There is enough evidence that physical exercise helps achieve mental health as well. The old saying, “sound mind in a sound

body” certainly has scientific basis.

Advantages of Physical Exercise⁹

- Moderate weight bearing exercise helps in prevention of osteoporosis and reduces the risk of fractures.
- Exercise helps in regulating glucose metabolism. Control of maturity onset diabetes becomes easier with the addition of regular exercise.
- Middle aged men and women following a physical fitness regime have less risk of premature death than their sedentary counterparts.
- Exercise, in conjunction with low calorie diet, helps in preventing obesity. It may be mentioned that obesity is a risk factor for coronary artery disease, diabetes and cancer.
- Aerobic exercises like brisk walking, swimming, bicycling, etc. which increase heart rate, improve cardiorespiratory function.
- Exercise strengthens muscles which, in turn, support the joints. Stabilization of joints permits one to bend and move freely. Osteoarthritis gets worse in the absence of such joint support.
- Regular exercise helps in lowering blood pressure. It tends to raise HDL and to lower blood cholesterol levels.¹⁰
- Physical exercise and fitness programs tend to make a person more self confident and relaxed with less tendency to depression.

Regular and frequent exercise is the key to physical fitness. If exercise sessions are missed for more than two weeks, a decline in fitness becomes apparent.⁹

According to recent work at NIN, trained athletes were able to perform physical work with lower heart rate compared to untrained controls. They also had higher respiratory quotient indicating predominance of aerobic mechanisms of energy transfer compared to untrained controls.^{10a,10b}

Spirituality

The term “spirituality” is used here in its wider sense for lack of a better word. It is not intended to have any religious connotation in the present context. It is now well known that physiological function can be influenced by mental processes. This, in fact, is the basis of psychosomatic medicine, a well established discipline. Transcendental meditation, yoga and biofeedback are already being used by modern medical scientists for management of hypertension. Positive thinking—filling the mind with energetic, happy, enthusiastic, creative thoughts—does help in achieving physical, mental and even social health. Development of positive thinking is promoted by two things.¹¹ First is regular physical exercise. Second is closeness to peaceful natural surroundings, such as seaside, riverside, lakeside, a walk in the garden or, even, listening to the rustle of leaves in a breeze.

A scientific basis for the concept of positive and negative thinking is provided by the new discipline of psychoneuroimmunology. Controlled studies have established that outcome of surgery depends upon the “morale” of the patient. Same surgery has higher success rate in patients who had higher morale, confidence and positive thinking prior to surgery. Similarly, negative thinking is associated with worse outcome of illness. A well controlled study by Dr Hahn in 1993 on ischemic heart disease showed that IHD morbidity and mortality was directly proportional to the degree of a feeling of hopelessness among the patients. Negative thinking was associated with 1.6 times higher incidence of IHD episodes and 1.5 times higher risk of death. He calculated that five percent deaths from IHD were attributable to patients’ negative expectations about the disease.^{2a} An even more dramatic example of the effect of negative thinking is the Vodoo deaths. Anthropologists found in Haiti that witch doctors can, by their suggestion, cause a person to fall ill, get worse and eventually die. The victims belief in witchcraft is so overpowering that he loses the will to live.^{2a}

Just as the aim of exercise is physical fitness, similarly the aim of spirituality is mental fitness. A physically fit person has control over various parts of his body and can use them easily and efficiently. Similarly, a mentally fit person should have control over his right and left brain, his thoughts and emotions, his desires and aspirations, etc. Only when he has control over his desires, i.e. only when he has will power, can he use his various mental faculties to his best advantage for achieving physical, mental and social health. “Spirituality”, “will power” or “positive thinking”, by whatever name we call it, is the most important determinant of lifestyle. A little reflection will reveal that it is basic to the other six components, which pertain to indulgence in food, alcohol, drugs, tobacco, sex and lethargy respectively.

As a matter of fact, all the seven components listed above have one thing in common—they reflect deviation from nature. Man has developed a capability to interfere with nature and go against the innate instincts and behavior pattern exhibited by all other mammals. As regards dietary intake, it is only man who stores and processes food, overeats and becomes obese. As regards intake of salt, sugar, alcohol, drugs and tobacco, these are obviously human distinctions. As regards sexual behavior, it is only man, among all mammals, who indulges in year round sex (other mammals have seasonal sex corresponding to estrous cycle) and consciously perpetuates homosexuality. As regards physical fitness, the hunter gatherer primitive man, like all other animals, had to perform hard physical

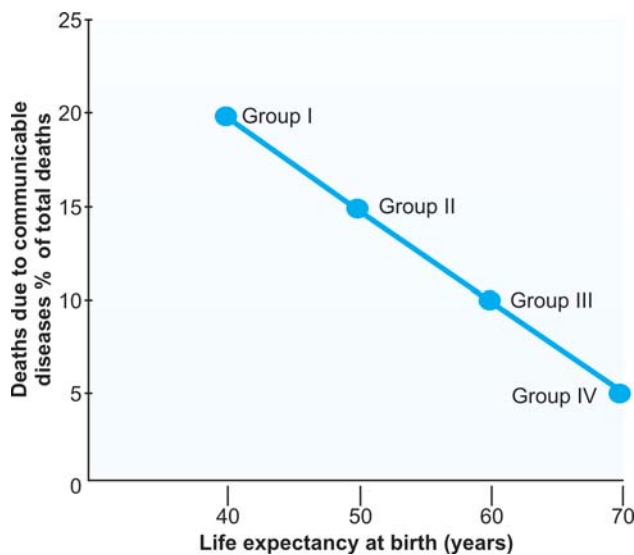
tasks to procure food. They did not have to bother about fitness programs.

Industrialization has been a major factor responsible for introducing “unnaturalness” in man’s environment. Machines have decreased the need for physical energy expenditure by man, leading to obesity. Mechanical “refining” of flour has resulted in decreased fiber intake, with all the diseases associated with this condition. The relation between diabetes and refined sugar intake is well known. The large number of chemicals in our environment, responsible for several preventable cancers, are the direct result of industrialization. Most of these chemicals are foreign to human body and lead to allergic conditions. According to a recent report, trends in modern life are responsible for an increase in prevalence and severity of asthma.¹²

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Communicable diseases in endemic or epidemic form have been taking a very heavy toll of human lives throughout history. Their incidence has reduced considerably due to better understanding of their epidemiological features, availability of specific chemotherapeutic agents and application of effective methods of prevention and control. The progress made in control of communicable diseases in India is reflected by the fact that smallpox has been eradicated from the world and guineaworm is almost eradicated from India. It is the control of communicable diseases which, to a large extent, has been responsible for the increase in life expectancy at birth in India from 19.4 in 1911 to 20, through 41.9 in 1951 to 60 to 58.6 in 1986 to 91. The relation between communicable diseases and life expectancy is clearly demonstrated in **Figure 15.1** where data from 20 Latin American countries is graphically presented. It is seen that as the proportion of deaths caused by infectious and parasitic diseases decreases from around 21 to 5 percent, there is marked increase in lifespan from 42 to 68 years.



Group I: Bolivia, Guatemala, Haiti, Honduras, Nicaragua and Paraguay

Group II: Columbia, Costa Rica, Ecuador, El Salvador, Peru, and Dominican Republic

Group III: Brazil, Chile and Mexico

Group IV: Argentina, Cuba, Panama, Uruguay and Venezuela

Fig. 15.1: Relation between communicable diseases and lifespan

The major communicable diseases in India are:

- Tetanus
- Rabies
- Cholera
- Enteric fever
- Amebiasis
- Ankylostomiasis and ascariasis
- Infective hepatitis
- Tuberculosis
- Diphtheria
- Whooping cough
- Measles
- Influenza
- Filariasis
- Arthropod borne virus infections
- Leprosy
- Polio
- Malaria
- Trachoma
- STD
- Scabies.

The environmental forces affecting the host and the agent are constantly changing the balance between the two. Disease occurs when the balance is in favor of the agent. Lodgement of the causative agent in the human host is only the initial requirement for occurrence of an infectious disease. The infection in the community is maintained through a chain of five events:

1. Entrance of the agent into skin or mucous membranes of alimentary canal, respiratory passages or genitourinary tract by direct or indirect contact.
2. Multiplication in a favorable site, organ or tissue of predilection.
3. Exit through body secretions or excretions or through blood sucking arthropods.
4. Survival in physical environment (such as air, water and soil) or biological environment (such as rats and arthropods).
5. Propagation to another host through man, animal, arthropod, food, air, water, etc.

Transmission of Infectious Agents

Transmission implies any mechanism by which an infectious agent is spread from a source or reservoir to a person. The various mechanisms of transmission as

described by the American Public Health Association are given below.

DIRECT TRANSMISSION

It is direct and essentially immediate transfer of an infectious agent to a receptive portal of entry through which human or animal infection can take place. This may be by direct contact, as by touching, biting, kissing or sexual intercourse, or by the direct projection (*droplet spread*) of droplet spray onto the conjunctiva or onto the mucous membranes of the eye, nose or mouth during sneezing, coughing, spitting, singing or talking (called *droplet spread*, usually limited to a distance of about 1 meter or less).

INDIRECT TRANSMISSION

Vehicle-borne

The examples of vehicles are contaminated inanimate materials or objects (fomites) such as toys, handkerchiefs, soiled clothes, bedding, cooking or eating utensils, surgical instruments or dressings (indirect contact); water, food, milk, biological products including blood, serum, plasma, tissues or organs; or any substance serving as an intermediate means by which an infectious agent is transported and introduced into a susceptible host through a suitable portal of entry. The agent may or may not have multiplied or developed in or on the vehicle before being transmitted.

Vector-borne

Mechanical: Includes simple mechanical carriage by a crawling or flying insect through soiling of its feet or proboscis, or by passage of organisms through its gastrointestinal tract. This does not require multiplication or development of the organism.

Biological: Propagation (multiplication), cyclic development or a combination of these (cyclopropagative) is required before the arthropod can transmit the infective form of the agent to man. An incubation period (extrinsic) is required following infection before the arthropod becomes infective. The infectious agent may be passed vertically to succeeding generations (*transovarian transmission*). *Transstadial transmission* indicates its passage from one stage of life cycle to another, as from nymph to adult. Transmission may be by injection of salivary gland fluid during biting, or by regurgitation or deposition on the skin of feces or other material capable of penetrating through the bite wound or through an area of trauma from scratching or rubbing. This transmission is by an infected nonvertebrate host and not simple mechanical carriage by a vector as a vehicle. However, an arthropod in either role is termed a vector.

Air-borne

The dissemination of microbial aerosols to a suitable portal of entry, usually the respiratory tract. Microbial aerosols are suspensions of particles in the air consisting partially or wholly of microorganisms. They may remain suspended in the air for long periods of time, some retaining and others losing infectivity or virulence. Particles in the 1 to 5 micron range are easily drawn into the alveoli of the lungs and may be retained there. Examples are droplet nuclei, and small dust particles. Large droplets and other large particles which promptly settle out are examples not of airborne transmission but rather of direct transmission of the droplet spread type.

Droplet nuclei: These are usually the small residues which result from evaporation of fluid from droplets emitted by an infected host as described. They usually remain suspended in air for long periods of time. They may also be created purposely by atomizing devices or may arise accidentally in microbiological laboratories, etc.

Dust: This includes small particles of widely varying size which may arise from soil (as, for example, fungus spores separated from dry soil by wind or mechanical agitation), clothes, bedding, or contaminated floors.

CONTROL MEASURES

From the point of view of control measures the communicable diseases can be classified into three categories.

- 1. Diseases requiring constant surveillance only:** Their preventive measures are known and effective. Examples are smallpox, typhoid, yellow fever, malaria, epidemic typhus, cholera and plague.
- 2. Diseases well understood but requiring more intensive application of the known preventive measures:** Examples are amebiasis, ascariasis, brucellosis, trachoma, diphtheria, guinea worm, ankylostomiasis, food poisoning, poliomyelitis, pneumonias, rabies, relapsing fever, ringworm, scabies, tapeworm infections, venereal diseases and tuberculosis.
- 3. Diseases requiring development of more effective preventive measures:** Examples are chickenpox, common cold, encephalitis, influenza, leprosy, leptospirosis, mumps, meningitis, rheumatic fever and streptococcal infections.

Definitions in Communicable Disease Epidemiology

If a microorganism, on entry into the body, produces disease, it is called a pathogen as against a commensal which lives in symbiosis and does not produce disease. Infection means entry, development and multiplication of a particular living pathogen in the body. It occurs in three forms.

1. *Subclinical or latent infection*, when no definite clinical manifestations are present.
2. *Typical infection*, which produces specific manifestation of disease.
3. *Atypical infection*, which produces atypical manifestations. Such cases are often missed, but these play an important role in the spread of disease.

Definitions relevant to communicable diseases as adopted by the American Public Health Association are given below.

Carrier

A person or animal that harbours a specific infectious agent in the absence of discernible clinical disease and serves as a potential source of infection. The carrier state may exist in an individual with an infection that is inapparent throughout its course (commonly known as healthy or asymptomatic carrier), or during the incubation period, convalescence, and postconvalescence of an individual with a clinically recognizable disease (commonly known as incubatory carrier or convalescent carrier). Under either circumstance the carrier state may be of short or long duration (temporary or transient carrier, or chronic carrier).

Case Fatality Rate

Usually expressed as a percentage of the number of persons diagnosed as having a specific disease who die as a result of that illness. This term is most frequently applied to a specific outbreak of acute disease in which all patients have been followed for an adequate period of time to include all attributable deaths. The case fatality rate must be clearly differentiated from mortality rate (qv). Synonyms: Fatality rate, fatality percentage.

Chemoprophylaxis

The administration of a chemical, including antibiotics, to prevent the development of an infection or the progression of an infection to active manifest disease. Chemotherapy, on the other hand, refers to use of chemical to cure a clinically recognizable disease or to limit its further progress.

Cleaning

The removal by scrubbing and washing, as with hot water, soap or suitable detergent or by vacuum cleaning, of infectious agents and of organic matter from surfaces on which and in which infectious agents may find favorable conditions for surviving or multiplying.

COMMUNICABLE DISEASE

An illness due to a specific infectious agent or its toxic products which arises through transmission of that agent

or its products from an infected person, animal, or inanimate reservoir to a susceptible host, either directly or indirectly through an intermediate plant or animal host, vector, or the inanimate environment (see also Transmission of Infectious Agents).

COMMUNICABLE PERIOD

The time or times during which an infectious agent may be transferred directly or indirectly from an infected person to another person, from an infected animal to man, or from an infected person to an animal, including arthropods.

In diseases such as diphtheria and streptococcal infection in which mucous membranes are involved from the initial entry of the infectious agent, the period of communicability is from the date of first exposure to a source of infection until the infecting microorganism is no longer disseminated from the involved mucous membranes, i.e. from the period before the prodromata until termination of a carrier state, if the latter develops. Some diseases are more communicable during the incubation period than during actual illness.

In diseases such as tuberculosis, leprosy, syphilis, gonorrhoea, and some of the salmonellosis, the communicable state may exist over a long and sometimes intermittent period when unhealed lesions permit the discharge of infectious agents from the surface of the skin or through any of the body orifices.

In disease transmitted by arthropods, such as malaria and yellow fever, the periods of communicability (or more properly infectivity) are those during which the infectious agent occurs in the blood or other tissues of the infected person in sufficient numbers to permit infection of the vector. A period of communicability (transmissibility) is also to be noted for the arthropod vector, namely, when the agent is present in the tissues of the arthropod in such form and locus (Infective state) as to be transmissible.

CONTACT

A person or animal that has been in an association with an infected person or animal or a contaminated environment that might provide an opportunity to acquire the infective agent.

CONTAMINATION

The presence of an infectious agent on a body surface; also on or in clothes, bedding, toys, surgical instruments or dressings, or other inanimate articles or substances including water and food. Pollution is distinct from contamination and implies the presence of offensive, but not necessarily infectious, matter in the environment. Contamination on a body surface does not imply a carrier state.

Disinfection

Killing of infectious agents outside the body by direct exposure to chemical or physical agents.

Concurrent disinfection is the application of disinfective measures as soon as possible after the discharge of infectious material from the body of an infected person, or after the soiling of articles with such infectious discharges; all personal contact with such discharges or articles minimized prior to such disinfection.

Terminal disinfection is the application of disinfective measures after the patient has been removed by death or to a hospital, or has ceased to be a source of infection, or after hospital isolation or other practices have been discontinued. Terminal disinfection is rarely practiced; terminal cleaning generally suffices (see Cleaning), along with airing and sunning of rooms, furniture and bedding. Disinfection is necessary only for diseases spread by indirect contact; steam sterilization or incineration of bedding and other items is recommended after a disease such as Lassa fever or other highly infectious diseases.

DISINFESTATION

Any physical or chemical process serving to destroy or remove undesired small animal forms, particularly arthropods or rodents, present upon the person, the clothing, or in the environment of an individual, or on domestic animals (see Insecticide and Rodenticide). Disinfestation includes delousing for infestation with *Pediculus humanus*, the body louse. Synonyms include the terms disinfection and disinsectization when only insects are involved.

Endemic

The constant presence of a disease or infectious agent within a given geographic area; may also refer to the usual prevalence of a given disease within such area. Hyperendemic expresses a persistent intense transmission and holoendemic a high level of infection beginning early in life and affecting most of the population, e.g. Malaria in some places (see Zoonosis).

Epidemic

The occurrence in a community or region of cases of an illness (or an outbreak) clearly in excess of expectancy. The number of cases indicating presence of an epidemic will vary according to the infectious agent, size and type of population exposed, previous experience or lack of exposure to the disease, and time and place of occurrence, epidemicity is thus relative to usual frequency of the disease in the same area, among the specified population, at the same season of the year. A single case of a communicable disease long absent

from a population or the first invasion by a disease not previously recognized in that area requires immediate reporting and epidemiologic investigation; two cases of such a disease associated in time and place are sufficient evidence of transmission to be considered an epidemic (see Zoonosis). Epidemic is said to exist if number of cases exceeds 2 standard error compared to previous 3 or 5 years.

Fumigation

Any process by which the killing of animal forms, especially arthropods and rodents, is accomplished by the use of gaseous agents (see Insecticide and Rodenticide).

HEALTH EDUCATION

Health education is the process by which individuals and groups of people learn to behave in a manner conducive to the promotion, maintenance or restoration of health. Education for health begins with people as they are, with whatever interests they may have in improving their living conditions. Its aim is to develop in them a sense of responsibility for health conditions, as individuals and as members of families and communities. In communicable disease control, health education commonly includes an appraisal of what is known by a population about a disease, an assessment of habits and attitudes of the people as they relate to spread and frequency of the disease, and the presentation of specific means to remedy observed deficiencies. Synonyms: Patient education, education for health, education of the public.

HERD IMMUNITY

The immunity of a group or community. The resistance of a group to invasion and spread of an infectious agent, based on the resistance to infection of a high proportion of individual members of the group. It provides an immunological barrier. Occurrence of clinical and subclinical infection in community determines the herd structure. It is never constant; rather it varies due to herd structure (new birth, death, in migration, out migration) and presence of an alternative host. In future it may lead to elimination of the disease (polio, measles). Herd immunity is never seen in tetanus and rabies.

Host

A person or other living animal, including birds and arthropods, that affords subsistence or lodgment to an infectious agent under natural (as opposed to experimental) conditions. Some protozoa and helminths pass successive stages in alternate hosts of different species. Hosts in which the parasite attains maturity or passes its sexual stage are primary or definitive hosts; those in which the parasite is in a larval or asexual state are secondary or intermediate hosts. A transport host is a

carrier in which the organism remains alive but does not undergo development.

IMMUNE INDIVIDUAL

A person or animal that has specific protective antibodies or cellular immunity as a result to previous infection or immunization, or is so conditioned by such previous specific experience as to respond adequately to prevent infection and/or clinical illness following exposure to a specific infectious agent. Immunity is relative: An ordinarily effective protection may be overwhelmed by an excessive dose of the infectious agent or by exposure through an unusual portal of entry; it may also be impaired by immunosuppressive drug therapy, concurrent disease, or the aging process (see Resistance).

IMMUNITY

That resistance usually associated with the presence of antibodies or cells having a specific action on the microorganism concerned with a particular infectious disease or on its toxin. Passive humoral immunity is attained either naturally by transplacental transfer from the mother, or artificially by inoculation of specific protective antibodies (From immunized animals, or convalescent hyperimmune serum or immune serum globulin (human); it is of short duration (days to months). Active humoral immunity, which usually lasts for years, is attained either naturally by infection with or without clinical manifestations, or artificially by inoculation of the agent itself in killed, modified or variant form, or of fractions or products of the agent. Effective immunity depends on cellular immunity which is conferred by T-lymphocyte sensitization, and humoral immunity which is based on B-lymphocyte response.

INAPPARENT INFECTION

The presence of infection in a host without recognizable clinical signs or symptoms. Inapparent infections are identifiable only by laboratory means or by the development of positive reactivity to specific skin tests. Synonyms: Asymptomatic, subclinical, occult infection.

INCIDENCE RATE

A quotient (rate), with the number of new cases of a specified disease diagnosed or reported during a defined period of time as the numerator, and the number of persons in a stated population in which the cases occurred as the denominator. This is usually expressed as cases per 1,000 or 100,000 per annum. This rate may be expressed as age or sex-specific or as specific for any other population characteristic or subdivision (see Morbidity rate and Prevalence rate).

Attack rate, or *case rate*, is an incidence rate often used for particular groups, observed for limited periods and under special circumstances, as in an epidemic, usually expressed as percent (cases per 100). The *secondary attack rate* in communicable disease practice expresses the number of cases among familial or institutional contacts occurring within the accepted incubation period following exposure to a primary case, in relation to the total of exposed contacts; it may be restricted to susceptible contacts when determinable. Infection rate expresses the incidence of all infections, manifest and inapparent.

INCUBATION PERIOD

The time interval between initial contact with an infectious agent and the appearance of the first sign of symptom of the disease in question, or, in a vector, of the first time transmission is possible (Extrinsic incubation period).

INFECTED INDIVIDUAL

A person or animal that harbors an infectious agent and who has either manifest disease (see Patient or sick person) or inapparent infection (see Carrier). An infectious person or animal is one from whom the infectious agent can be naturally acquired.

Infection

The entry and development or multiplication of an infectious agent in the body of man or animals. Infection is not synonymous with infectious disease; the result may be inapparent (see inapparent Infection) or manifest (see Infectious disease). The presence of living infectious agents on exterior surfaces of the body, or upon articles of apparel or soiled articles, is not infection, but represents contamination of such surfaces and articles (see Contamination).

INFECTIOUS AGENT

An organism (Virus, rickettsia, bacteria, fungus, protozoa or helminth) that is capable of producing infection or infectious disease.

INFECTIOUS DISEASE

For persons or animals, the lodgement, development and reproduction of arthropods on the surface of the body or in the clothing. Infested articles or premises are those which harbor or give shelter to animal forms, especially arthropods and rodents.

INFESTATION

For persons or animals, the lodgment, development and reproduction of arthropods on the surface of the body

or in the clothing. Infested articles or premises are those which harbor or give shelter to animal forms, especially arthropods and rodents.

INSECTICIDE

Any chemical substance used for the destruction of insects, whether applied as powder, liquid, atomized liquid, aerosol, or as a “paint” spray; residual action is usual. The term larvicide is generally used to designate insecticides applied specifically for destruction of immature stages of arthropods; adulticide or imagocide, to designate those applied to destroy mature or adult forms. The term insecticide is often used broadly to encompass substances for the destruction of all arthropods, but acaricide is more properly used for agents against ticks and mites. More specific terms, such as lousicide and miticide are sometimes used.

ISOLATION

As applied to patients, isolation represents separation, for the period of communicability of infected persons or animals from others in such places and under such conditions as to prevent or limit the direct or indirect transmission of the infectious agent from those infected to those who are susceptible or who may spread the agent to others. In contrast, quarantine (qv) applies to restrictions on the healthy contacts of an infectious case. Recommendations which are made for isolation of cases are the methods recommended by CDC. The recommendations are divided into 7 categories.

Two basic requirements are common for all 7 categories.

- *Hands must be washed after contact with the patient or potentially contaminated articles and before taking care of another patient*
- *Articles contaminated with infectious material should be appropriately discarded or bagged and labeled before being sent for decontamination and reprocessing.*

The seven categories are:

1. *Strict isolation:* This category is designed to prevent transmission of highly contagious or virulent infections that may be spread by both air and contact. The specifications, in addition to those above, include a private room and the use of masks, gowns and gloves for all persons entering the room. Special ventilation requirements with the room at negative pressure to surrounding areas is desirable.
2. *Contact isolation:* For less highly transmissible or serious infections, for diseases or conditions which are spread primarily by close or direct contact. In addition to the basic requirements, a private room is indicated but patients infected with the same pathogen may share a room. Masks are indicated for those who come close to the patient, gowns are indicated if soiling is likely, and gloves are indicated for touching infectious material.
3. *Respiratory isolation:* To prevent transmission of infectious diseases over short distances through the air, a private room is indicated but patients infected with the same organism may share a room. In addition to the basic requirements, masks are indicated for those who come in close contact with the patient, gowns and gloves are not indicated.
4. *Tuberculosis isolation (AFB isolation):* For patients with pulmonary tuberculosis who have a positive sputum smear or chest X-rays which strongly suggest active tuberculosis. Specifications include use of a private room with special ventilation and the door closed. In addition to the basic requirements, masks are used only if the patient is coughing and does not reliably and consistently cover the mouth. Gowns are used to prevent gross contamination of clothing. Gloves are not indicated.
5. *Enteric precautions:* For infections transmitted by direct or indirect contact with feces. In addition to the basic requirements, specifications include use of a private room if patient hygiene is poor. Masks are not indicated, gowns should be used if soiling is likely and gloves are to be used for touching contaminated materials.
6. *Drainage/secretion precautions:* To prevent infections transmitted by direct or indirect contact with purulent material or drainage from an infected body site. A private room and masking are not indicated, in addition to the basic requirements, gowns should be used if soiling is likely and gloves used for touching contaminated materials.
7. *Blood/body fluid precautions:* To prevent infections that are transmitted by direct or indirect contact with infected blood or body fluids. In addition to the basic requirements, a private room is indicated if patient hygiene is poor, masks are not indicated but gowns should be used if soiling of clothing with blood or body fluids is likely. Gloves should be used for touching blood or body fluids.

A recent CDC recommendation states that blood and body fluid precautions be used consistently for all patients (in-hospital settings as well as outpatient settings) regardless of their bloodborne infection status. This extension of the blood and body fluid precautions to all patients is known as “Universal blood and body fluid precautions” or “Universal precautions”. In this, blood and certain body fluids (any visibly bloody body secretion, semen, vaginal secretions, tissue, CSF, and synovial, pleural, peritoneal, pericardial, and amniotic fluids) of all patients are considered potentially infectious for HIV, HBV, and other bloodborne pathogens.

Universal precautions are intended to prevent parenteral, mucous membrane, and nonintact skin exposures of health care workers to bloodborne pathogens. Protective barriers include gloves, gowns,

masks and protective eyewear or face shields. Waste management is controlled by local and state authority.

Molluscide

A chemical substance used for the destruction of snails and other molluscs.

MORBIDITY RATE

An incidence rate (qv) used to include all persons in the population under consideration who become clinically ill during the period of time stated. The population may be limited to a specific sex, age group or those with certain other characteristics.

MORTALITY RATE

A rate calculated in the same way as an incidence rate (qv), using as a numerator the number of deaths occurring in the population during the stated period of time, usually a year. A total or crude mortality rate utilizes deaths from all causes, usually expressed as deaths per 1,000 while a disease-specific mortality rate include only deaths due to one disease and is usually reported on the basis of 10,000 persons. The population base may be defined by sex, age or other characteristics. The mortality rate must not be confused with case fatality rate (qv).

NOSOCOMIAL INFECTION

An infection occurring in a patient in a hospital or other health care facility and in whom it was not present or incubating at the time of admission, or the residual of an infection acquired during a previous admission. Includes infections acquired in the hospital but appearing after discharge, and also such infections among the staff of the facility.

Pathogenicity

The capability of an infectious agent to cause disease in a susceptible host.

PATIENT OR SICK PERSON

A person who is ill.

PERSONAL HYGIENE

Those protective measures, primarily within the responsibility of the individual, which promote health and limit the spread of infectious diseases, chiefly those transmitted by direct contact. Such measures encompass (a) washing hands in soap and water immediately after evacuating bowels or bladder and always before handling food or eating, (b) keeping hands and unclean articles, or articles that have been used for toilet

purposes by others, away from the mouth, nose, eyes, ears, genitalia and wounds, (c) avoiding the use of common or unclean eating utensils, drinking cups, towels, handkerchiefs, combs, hairbrushes and pipes, (d) avoiding exposure of other persons to spray from the nose and mouth as in coughing, sneezing, laughing or talking, (e) washing hands thoroughly after handling a patient or his belongings, and (f) keeping the body clean by sufficiently frequent soap and water baths.

PREVALENCE RATE

A quotient (rate) obtained by using as the numerator the number of persons sick or portraying a certain condition in a stated population at a particular time (point prevalence), or during a stated period of time (period prevalence), regardless of when that illness or condition began, and as the denominator the number of persons in the population in which they occurred.

QUARANTINE

Restriction of the activities of well persons or animals who have been exposed to a case of communicable disease during its period of communicability (i.e. contacts) to prevent disease transmission, during the incubation period if infection should occur.

Absolute or complete quarantine: The limitation of freedom of movement of those exposed to a communicable disease for a period of time not longer than the longest usual incubation period of that disease, in such manner as to prevent effective contact with those not so exposed (see Isolation).

Modified quarantine: A selective, partial limitation of freedom of movement of contacts, commonly on the basis of known or presumed differences in susceptibility and related to the danger of disease transmission. It may be designed to meet particular situations. Examples are exclusion of children from school, exemption of immune persons from provisions applicable to susceptible persons, or restriction of military populations to the post or to quarters. It includes: Personal surveillance, the practice of close medical or other supervision of contacts in order to permit prompt recognition of infection or illness but without restricting their movements, and Segregation, the separation of some part of a group of persons or domestic animals from the others for special consideration, control or observation—removal of susceptible children to homes of immune persons, or establishment of a sanitary boundary to protect uninfected from infected portions of a population.

Note: Quarantine has lost its importance now as better methods of control have become known. It is especially so in a situation when smallpox has been eradicated and yellow fever has been recognized to be essentially a sylvatic disease.

Repellent

A chemical applied to the skin or clothing or other places to discourage (a) arthropods from alighting on and attacking an individual, or (b) other agents, such as helminth larvae, from penetrating the skin.

RESERVOIR (OF INFECTIOUS AGENTS)

Any person, animal, arthropod, plant, soil or substance (or combination of these) in which an infectious agent normally lives and multiplies, on which it depends primarily for survival, and where it reproduces itself in such manner that it can be transmitted to a susceptible host.

Resistance

The sum total of body mechanisms which interpose barriers to the progress of invasion or multiplication of infectious agents or to damage by their toxic products. Inherent resistance—an ability to resist disease independent of antibodies or of specifically developed tissue response; it commonly resides in anatomic or physiologic characteristics of the host and may be genetic or acquired, permanent or temporary. Synonym: Non-specific immunity (see Immunity).

Rodenticide

A chemical substance used for the destruction of rodents, generally through ingestion (see Fumigation).

SOURCE OF INFECTION

The person, animal, object or substance from which an infectious agent passes to a host. Source of infection should be clearly distinguished from source of contamination, such as overflow of a septic tank contaminating a water supply, or an infected cook contaminating a salad (see Reservoir).

SURVEILLANCE OF DISEASE

As distinct from surveillance of persons (see Quarantine, b), surveillance of disease is the continuing scrutiny of all aspects of occurrence and spread of a disease that are pertinent to effective control. Included are the systematic collection and evaluation of:

- Morbidity and mortality reports.
- Special reports of field investigations of epidemics and of individual cases.
- Isolation and identification of infectious agents by laboratories.
- Data concerning the availability, use and untoward effect of vaccines and toxoids, immunoglobulins, insecticides, and other substances used in control
- Information regarding immunity levels in segments of the population.

- Other relevant epidemiologic data. A report summarizing the above data should be prepared and distributed to all cooperating persons and others with a need to know the results of the surveillance activities.

The procedure applies to all jurisdictional levels of public health from local to international. Serologic surveillance identifies patterns of current and past infection using serologic tests.

SUSCEPTIBLE

A person or animal presumably not possessing sufficient resistance against a particular pathogenic agent to prevent contracting infection or disease if or when exposed to the agent.

SUSPECT

A person whose medical history and symptoms suggest that he or she may have or be developing some communicable disease.

TRANSMISSION OF INFECTIOUS AGENTS

Any mechanism by which an infectious agents is spread from a source or reservoir to a person. These mechanism are:

Direct Transmission

Direct and essentially immediate transfer of infectious agents to a receptive portal of entry through which human or animal infection may take place. This may be by direct contact as by touching, biting, kissing or sexual intercourse, or by the direct projection (droplet spread) of droplet spray onto the conjunctiva or onto the mucous membranes of the eye, nose or mouth during sneezing, coughing, spitting, singing or talking (Usually limited to a distance of about 1 meter or less).

Indirect Transmission

- *Vehicle-borne*: Contaminated inanimate materials or object (fomites) such as toys, handkerchiefs, soiled clothes, bedding, cooking or eating utensils, surgical instruments or dressings (indirect contact); water, food, milk, biological products including blood, serum, plasma, tissues or organs, or any substance serving as an intermediate means by which an infectious agents is transported and introduced into a susceptible host through a suitable portal of entry. The agent may or may not have multiplied or developed in or on the vehicle before being transmitted.
- *Vector-borne*:
 - *Mechanical*: Includes simple mechanical carriage by a crawling or flying insect through soiling of its feet or proboscis, or by passage of organisms through its gastrointestinal tract. This does not require multiplication or development of the organism.

- Biological: Propagation (multiplication), cyclic development, or a combination of these (cyclo-propagative) is required before the arthropod can transmit the infective form of the agent to man. An incubation period (extrinsic) is required following infection before the arthropod becomes infective. The infectious agent may be passed vertically to succeeding generations (transovarian transmission); transstadial transmission indicates its passage from one stage of life cycle to another, as nymph to adult. Transmission may be by injection of salivary gland fluid during biting, or by regurgitation or deposition on the skin of feces or other material capable of penetrating through the bite wound or through an area of trauma from scratching or rubbing. This transmission is by an infected nonvertebrate host and not simple mechanical carriage by a vector as a vehicle. However, an arthropod in either role is termed a vector.
- *Air-borne*: The dissemination of microbial aerosols to a suitable portal of entry, usually the respiratory tract. Microbial aerosols are suspensions of particles in the air consisting partially or wholly of micro-organisms. They may remain suspended in the air for long periods of time, some retraining and others losing infectivity or virulence. Particles in the 1 to 5 mm range are easily drawn into the alveoli of the lungs and may be retained there. Not considered as air-borne are droplets and other large particles which promptly settle out (see Direct Transmission, above).
 - *Droplet nuclei*: Usually the small residues which result from evaporation of fluid from droplets emitted by an infected host (see above). They also may be created purposely by a variety of atomizing devices, or accidentally as in microbiology laboratories or in abattoirs, rendering plants or autopsy rooms. They usually remain suspended in the air for long period of time.
 - *Dust*: The small particles of widely varying size which may arise from soil (as, for example, fungus spores separated from dry soil by wind or mechanical agitation), clothes, bedding, or contaminated floors.

Virulence

The degree of pathogenicity of an infectious agent, indicated by case fatality rates and/or its ability to invade and damage tissues of the host.

ZOONOSIS

An infection or infectious disease transmissible under natural conditions from vertebrate animals to man. May be enzootic or epizootic (see Endemic and Epidemic).

Epidemiological Description of Communicable Diseases

COMMUNICABLE DISEASES IN GENERAL

The collection of information in case of communicable diseases should follow a definite pattern so that no important aspects are missed. A standard proforma is described below for this purpose. This proforma will be followed for describing communicable diseases in the next four chapters as far as feasible.

IDENTIFICATION OF CASES OF DISEASE

Clinical, laboratory and field investigations are made to identify the cases reported. Field diagnosis may be more important than the laboratory report in some cases, e.g. Cholera and food poisoning.

INFECTIOUS AGENT

It means the causative agent of disease. Its nature, infectivity, virulence, antigenicity and viability in the environment should be described.

OCCURRENCE

A longitudinal or vertical study of the past occurrence and distribution of the disease is made. Also, the cross-sectional or horizontal extent of the disease is determined by finding the total cases, new and old in the area at any one time, expressed as per thousand population.

RESERVOIR

This refers to the source from where the infection is contacted. Most often, the source is man himself, either as a patient or as a carrier. Common examples are the mild and missed cases in cholera or dysentery, healthy carriers in diphtheria and convalescent carriers in typhoid. Sometimes the source is an animal reservoir. Dog is the source for rabies and hydatid cyst disease and rat for plague, Weil's disease, endemic typhus, rat bite fever and salmonellosis. Rarely, the source may be soil, as in case of tetanus, botulism and gas gangrene infections.

MODE OF TRANSMISSION AND SPREAD

This includes the following: the route and mode of exit of an infectious agent from the source, i.e. the diseased person or an animal, the vehicle and mode of travel, the route and mode of entry into the body of a new host.

Mode of exit: The agent comes out of the body of the diseased through:

- Mouth and nose, along with breath and droplets
- Anus, urethra or vagina, along with feces and discharges

- Skin and mucous membranes (direct contact)
- Blood (through insect bites, injections and trauma).

Mode of travel: The infection may travel or spread:

- *Directly* or without a vehicle. This may happen through droplets (by close proximity, such as in common cold and influenza) or through skin and mucous membranes (by close bodily contact such as in venereal diseases, leprosy, and ophthalmia neonatorum).
- *Indirectly*, through a vehicle. The vehicle may be animate or inanimate. Examples of the former are man himself and various arthropods. Examples of inanimate vehicles are air, water, food, dust and fomites.

Mode of entry: The agent enters the new host by the following routes:

- *Respiratory passages:* The infection enters directly with the droplets on inhalation of the contaminated air or dust.
- *Alimentary canal:* The infection enters by ingestion of contaminated water and food.
- *Skin and mucous membranes:* The infection enters directly by body or sex contact with or indirectly through contaminated articles (socks, shoes, kajaal stick, etc.) used by the infected person.
- *Blood:* The agent enters the body through bite of arthropod vectors, through injections using contaminated syringes and needles or through injury caused by nails, thorns or other piercing objects. Sometimes transplacental spread may occur from the mother to fetus through placenta. Syphilis is a common example.

INCUBATION PERIOD

This should be stated as the average and the range. It helps in the diagnosis of disease, in tracing the source of infection and in determining the quarantine period.

PERIOD OF COMMUNICABILITY

This is the period during which the patient is infective. It may include the whole or part of the incubation period, the disease period, the convalescence, as also the post-convalescence period if the patient continues to discharge the infective organism. The period of communicability varies in different diseases. Poliomyelitis and infectious hepatitis patients are more infective during incubation period and the early part of disease. Whooping cough cases are more infective during the first week of the disease and much less so afterwards. A typhoid case, on the other hand, is infective after a week or 10 days of the disease. The period of communicability is very important because it determines the period of isolation.

SUSCEPTIBILITY AND RESISTANCE

These pertain to host factors that affect proneness to infection. Important factors are age, sex, race, heredity and immune status.

METHODS OF CONTROL

Spread of infection may be controlled by exercising a check at the level of the reservoir, the host or the transmission from reservoir to the host. Of these three, the first is the most difficult to check, especially when man himself is the reservoir. It may be less difficult when the reservoir is an animal.

The most vulnerable factor in the spread of a disease is the route of transmission and all attempts should be made to block this route. An attempt should also be made to clean the environment and to increase host resistance. Unless all the links in the chain are present, disease transmission cannot take place. The best course for control of a communicable disease is to attack the weakest link first, subject to factors like cost, practicability and acceptance by the people. Examples of control measures are treatment of open cases of tuberculosis (preventing exit of agent), mosquito control measures for malaria (preventing vehicle transmission) and wearing shoes in the fields for hookworm (prevention of entry of the agent).

The methods of control are described under the following headings in the standard format of description.⁵

- Preventive measures
- Control of patients, contacts and the immediate environment as per the following six aspects:
 - Report to local health authority
 - Isolation
 - Concurrent disinfection
 - Immunization of contacts
 - Investigation of contacts
 - Specific treatment
- Epidemic measures
- Disaster implications
- International measures.

APPROACH TO ACUTE COMMUNICABLE DISEASES

The purpose of describing the disease entity under the above nine headings is to be able to apply epidemiologically sound and effective methods for prevention and control of disease. However, in case of acute communicable diseases, it is better to stick to the following routine of specific and standard methods from a practical point of view.

Notification

Cases of an acute infectious disease should be reported promptly to the appropriate health authority. The latter

may consider it necessary to detect all cases through a house to house survey.

Isolation

Already described.

Quarantine

Already described.

Diagnosis

Proper diagnosis is very important for the adoption of control measures and should be made as early as possible from the clinical picture, supported by appropriate laboratory tests, whenever possible.

SPECIFIC TREATMENT

This is the main method of control in some diseases as chemotherapy helps in decreasing the quantum of infection in the community. Examples are leprosy, tuberculosis and malaria.

Disinfection

Described later in this chapter.

Immunization

Personal and mass immunization should be undertaken during the epidemic or even before hand when the epidemic is threatened.

INVESTIGATION OF CONTACTS AND SOURCE OF INFECTION

Contact tracing helps in early detection of mild and missed cases. The source of the infection, if found, should be effectively dealt with to prevent further spread of disease.

HEALTH EDUCATION

This includes the methods of publicity and education, aimed at instructing the people about steps to be taken during an epidemic.

LEGAL AND ADMINISTRATIVE MEASURES

Legal compulsion may be necessary to enforce certain antiepidemic measures such as prohibition of the use of a contaminated well. In olden days, vaccination against smallpox had to be compulsorily enforced in some villages.

LONG-TERM MEASURES

These are measures to be adopted during the interepidemic period, with the aim of forestalling or

delaying future epidemics. Various sanitation and immunization measures belong to this category.

INTERNATIONAL MEASURES

They are applied to prevent the spread of infection from one country to another (e.g. Yellow fever regulations).

DISINFECTION AND DISINFECTANTS

Bacteria, though agents of disease, also form part of the environment of man. Harmful bacteria have to be destroyed at the original source or reservoir which may be man, animal or an inanimate object. Disinfection has already been defined. *Disinfectants* are substances that destroy harmful microbes. They are meant for application to inanimate objects and are usually ineffective against spores. Substances or processes that destroy bacteria as well as the spores are called *sterilizing agents*. *Antiseptics* are bactericidal or bacteriostatic substances suitable for use upon living tissues. Disinfectants may sometimes be used as antiseptics in low concentrations. On the other hand, chemotherapeutic drugs and antibiotics are the substances used internally. *Chemotherapeutic agents* are chemicals which, when taken in, kill the bacteria or inhibit their growth but do not damage the body cells. Examples are sulphonamides, sulphones, antimalarials, antiamebics and anthelmintics. *Antibiotics* are chemical substances produced by microorganisms that destroy bacteria or inhibit their growth but do not damage body cells. Examples—Penicillin, streptomycin and tetracyclines.

Disinfectants act through three mechanisms:

1. Coagulation of protoplasm, as in case of heat and metallic salts.
2. Oxidation and burning of protoplasm, as in case of potassium permanganate and halogen compounds.
3. Interference with cell metabolism, as in case of phenol compounds.

PHYSICAL DISINFECTANTS

They are sunlight, including ultraviolet rays, air, heat and ionizing radiation.

Sunlight

It is a natural disinfectant that destroys bacteria in air, water, and fomites. Direct sunlight is more effective than diffuse light. Short wave radiation, such as ultraviolet rays, is more bactericidal than long wave radiation, such as infrared rays. The penetrating power of ultraviolet light is low and it cannot pass through glass. Addition of fluorescent dyes such as eosin or methylene blue enhances the lethal effect of ultraviolet rays through photodynamic action. Ultraviolet light is used for water disinfection in swimming pools.

Air

Fresh, moving, dry air dilutes the bacterial concentration in the atmosphere. It disseminates the bacteria, dries them and exposes them to the action of sunlight. Dessication or drying is an important procedure employed in preservation of foods. Vacuum drying preserves the potency of vaccines and helps in maintaining the nutritive values in foods. Devoid of moisture, bacteria become inactive and cannot grow.

Heat

It is utilized on a large scale as a disinfectant in different fields of medicine and in preservation of foods. It can be used as dry or moist heat.

Dry heat: It is applied in the form of dry hot air or fire. Heat coagulates the protoplasm. Bacteria are killed in hot air oven in 1 to 2 hours at 100°C while spores are killed in 3 hours at 140°C and in one hour at 160°C. This method is used to sterilize articles that are liable to be damaged by moist heat but can stand prolonged heating. Examples are glassware, paper, wool, etc. Fire is used for flaming needles and burning cheap contaminated articles such as linen and other fomites.

Moist heat: It is used in the form of boiling water or steam. It has greater power of penetration.

Boiling water: It is a cheap, handy and reliable disinfectant. All pathogenic bacteria die below 63°C in half an hour, a fact made use of in pasteurization of milk. Boiling for 5 minutes kills even spores, especially in closed vessels, such as pressure cookers and autoclaves, where temperature rises above 100°C. The boiling point of water is raised to 121°C at a pressure of 1.1 kg/cm² (15 lbs per sq inch) and to 134°C at 2.3 kg/cm² (32 lbs per sq inch). Addition of 2 percent washing soda enhances the germicidal power. Clothes with albuminous matter should be soaked in cold water for some time and then heated, otherwise the albuminous stains get fixed by the action of heat. Moist heat may cause shrinkage of woollen clothes and hence is not suitable for them.

Steam: It is the most efficient disinfecting agent. Its efficiency is partly attributable to its large amount of latent heat (540 cal/g) which is given out on condensation. That is why saturated steam, as in an autoclave, is very effective, while dry, unsaturated steam, even though superheated, acts more or less like dry air. Steam disinfection is employed in hospitals to disinfect linen on a large scale. Its great penetrating power helps in quick disinfection of linen and cotton. Steam at 100°C destroys all bacteria and spores in 5 minutes.

Ionizing Radiation

It is a safe and effective method that is being increasingly used for sterilization of bandages, syringes, needles, catheters and other medical equipment. The material to be sterilized is properly packed in plastic containers and exposed to gamma rays which are highly penetrating.

Beside the above four methods of disinfection by physical means, bacteria can also be removed by mechanical devices like filters (e.g. Berkefeld, Pasteur-Chamberland and Sietz filters) and coagulants (e.g. alum).

CHEMICAL DISINFECTANTS

Qualities of a good disinfectant: It should:

- Not be poisonous to higher animals
- Not corrode metals or damage fabrics
- Not bleach or stain
- Not have unpleasant smell
- Not deposit out from suspension or solution
- Not be influenced by the presence of organic matter
- Be cheap
- Be readily miscible with water
- Be stable
- Act both in acid and alkaline medium
- Have a fair power of penetration.

STANDARDIZATION OF DISINFECTANTS

Bactericidal activity of a disinfectant is compared in relation to that of phenol and is expressed as '*carbolic coefficient*'. If a chemical has a coefficient of 5, it means the chemical is 5 times stronger than phenol. In other words, a 1 percent solution of this chemical will kill the same number of typhoid bacilli as 5 percent carbolic acid. Formerly, the comparison was made without the presence of organic matter (Rideal-Walker test) but now the test is performed in the presence of organic matter (Chick-Martin test). The phenol or carbolic method has now been replaced by the use-dilution method.

FACTORS AFFECTING DISINFECTANT ACTION

The extent of action of a chemical disinfectant depends on:

- Nature and number of microorganisms
- Concentration of the disinfectant
- Presence or absence of organic matter
- Duration of action
- Temperature
- Nature of the solvent.

Phenol and Related Compounds

They are employed on a large scale. They are convenient to use and are easily available. They are effective even in the presence of organic matter.

Carbolic acid or phenol: In pure form, it is found as colorless crystals which turn pink and then red on exposure to air. The pure form is not as effective as the crude form, which contains some cresol as well. Crude phenol is the one commonly used. It is a dark oily liquid. It is used in 5 percent strength for mopping floors and walls and in 10 percent strength for disinfecting thermometers and linen and for disposal of secretions and excreta (e.g. in bedpans used for collection of stools and in sputum cups used by patients of tuberculosis). It is effective against gram positive and gram negative bacteria but not much against acid fast bacilli and spores. It is used in 20 percent strength for sterilizing surgical instruments. Aqueous solutions in 0.2 to 1 percent strength have bacteriostatic action.

Cresol: It is 3 to 10 times more powerful than phenol without being more toxic. Cresol emulsions are very potent and useful all purpose general disinfectants. Examples are saponified cresol, izalcyllin and cresol. The last is a popular preparation containing 50 to 60 percent of cresol with carbolic coefficient of 5 to 10 and is commonly used as 1 percent solution to disinfect hands, 2 percent for clothes and 2 to 5 percent for excreta.

Chlorhexidine (Hibitane): It is a very useful skin disinfectant. A 0.5 percent aqueous or alcoholic solution can be used as a hand lotion and 0.1 percent preparation can be used as a cream or lotion for disinfection of hands and burns. It is highly active against gram positive and moderately active against gram negative organisms, but is inactivated by soaps and detergents.

Chloroxynol (Dettol): It is widely used in surgical and medical practice for disinfecting wounds, hands, etc. It is active against streptococci but not so much against gram negative organisms. It is easily inactivated by organic matter. It is nontoxic even in high concentration.

Quaternary Ammonium Compounds

A common example is cetrime (Cetavlon), which is used in 1 to 2 percent strength to disinfect wounds and to clean skin and hands. Its bactericidal action is mainly against gram positive organisms. Savlon is a combination of cetrime and chlorhexidine.

Halogens and Related Compounds

Bleaching powder: Or chlorinated lime is used to disinfect well water. Presence of organic matter reduces its efficacy. It can also be used to disinfect stools and urine. For this purpose, a 5 percent solution of bleaching powder is used. Excreta are disinfected in an hour.

Hypochlorites: They are widely accepted as disinfectants and sanitizers in industry, schools, hospitals, restaurants, etc. They are available as powders or liquids. Common preparations are sodium, calcium and lithium hypochlorite.

Chlorine tablets: These release chlorine and are used to disinfect water.

Iodine: This is a time tested disinfectant. Tincture iodine is a valuable antiseptic widely used in hospitals and dispensaries. Plastic appliances may be sterilized by 1:2500 iodine solution prepared by adding 20 ml of 2 percent tincture iodine to one liter water.

Iodophors: An iodophor is a loose complex of elemental iodine or triiodide with a carrier which increases the solubility of iodine and provides a sustained release iodine reservoir. The best known example is povidone iodine (Betadin).

Formalin

It is the 40 percent aqueous solution of formaldehyde. It irritates nose and eyes. It does not affect metals, except iron. It is used along with glycerine as a liquid spray to disinfect rooms (1 part formalin, 1 part glycerine and 20 parts water). Formalin is effective against bacteria, fungi and some viruses. It is not much effective against spores and acid fast bacilli.

Alcohol

The methylated spirit commonly used in clinical practice as a disinfectant is a combination of methyl and ethyl alcohol. 70 percent alcohol is a good disinfectant. Alcoholic solutions of chlorhexidine and iodine are effective and widely used disinfectants.

Miscellaneous

Soap: It is a good cleansing agent for hands and the body. It washes off dust and bacteria by its detergent action. Hot water and good lather enhance the action of soap.

Mercury perchlor: It kills spores in 1 hour in 1:500 solution and microorganisms in half an hour in 1:1000 strength. It coagulates albuminous matter and corrodes metals, hence it can be used only for disinfection of hands.

Potassium permanganate: It is a weak disinfectant rendered inert in the presence of organic matter. A 1:1000 solution is used to wash vegetables, fruits, and utensils. Sometimes it is used to disinfect drinking water.

Lime: It is an effective and inexpensive disinfectant. Sometimes it is used to disinfect water also. Dry lime may be spread on floors as a disinfectant. It may be mixed with stools as milk of lime (10 to 20 percent suspension in water) in 2:1 ratio and left for 4 hours before disposal. Walls are disinfected by white washing with 10 percent milk of lime. A comprehensive classification of disinfectants and antiseptics is given in **Table 15.1**.

TABLE 15.1: Classification of disinfectants and antiseptics

- *Chlorine and Chlorine Compounds*
 - Chlorine
 - Hypochlorites
 - Chlorine dioxide
 - Inorganic chloramines
 - Organic chloramines
 - Halazone.
- *Iodine and Iodine Compounds*
 - Solutions of free iodine and triiodide, e.g. tincture iodine
 - Iodophors,^{*} e.g. povidone iodine
 - Preparations producing iodine in contact with water,^{**} e.g. haliogen (a mixture of chloramine-T, potassium iodide and certain inert substances)
 - Organic iodine compounds, e.g. iodoform (triiodomethane), diiodoquin.
- *Phenolic Compounds*
 - Phenol and its homologues, e.g. cresol
 - Alogenated phenol derivatives, e.g. hexachlorophenol, chlorothyinol, etc.
- *Alcohols*
- *Hydrogen peroxide and other oxidants (e.g. ozone, peracids, potassium permanganate)*
- *Chlorhexidine (Hibitane)*
- *Nitrogen Compounds*
 - *Formaldehyde releasing compounds*, e.g. hexamine, used as urinary antiseptic
 - *Nitrate and nitrites*: Mainly as preservatives
 - *Dyes*
 - *Pyridines*, e.g. pyridinethiols used as preservatives and as disinfectants in shampoos
 - *Thiazoles and mercaptobenzothiazole*
 - *Nitro derivatives of phenols*
 - *Anilides*
 - *Quinolines*.
- *Surface Active Agents*
 - *Quaternary ammonium compounds*, e.g. cetrimide
 - *Acid anionic compounds*
 - *Amphoteric compounds*, e.g. tego.
- *Mercurials*, e.g. mercury chlorides, mercurochrome, nitromersol, merthiolate
- *Silver and its compounds*, e.g. silver nitrate, colloidal silver.

^{*}An iodophor is a loose complex of elemental iodine or triiodide with a carrier which increases the solubility of iodine and provides a sustained release iodine reservoir.

^{**}These preparations contain iodides and not elemental iodine.

When the iodide and an oxidant come in contact with water, iodine is produced.

CLASSIFICATION OF COMMUNICABLE DISEASES

A convenient method is to classify communicable diseases according to the mode of transmission. Such classification facilitates the control of these diseases because transmission is the most vulnerable part in the chain of spread. The measures of prevention and control, in general, are similar for diseases in the same group. It is often difficult to tackle the host, i.e. the man. It is again relatively difficult to tackle the causative agent at the source since the source, in most cases is the man himself. In practice, one finds it comparatively easier to attack the agent in the environment in relation to the vehicle of transmission. In this background, communicable diseases are grouped into airborne or respiratory infections, water

TABLE 15.2: Air borne or respiratory infections

Viral	Bacterial
a. <i>General</i>	a. <i>General</i>
1. Common cold	1. Pneumonia
2. Influenza	2. Streptococcal sore throat, acute glomerulonephritis and rheumatic fever
3. Adenovirus infections	
4. Viral encephalitis	
b. <i>Specific</i>	b. <i>Specific</i> [*]
1. Smallpox	1. Diphtheria
2. Chickenpox	2. Whooping cough
3. Measles	3. Tuberculosis
4. Rubella	4. Meningococcal meningitis
5. Mumps	

^{*}Leprosy infection also enters through respiratory tract, but is usually grouped under contact or surface infections.

and food-borne or intestinal infections, contact or surface infections and arthropod-borne infections.

Air-borne Infections

In this group **Table 15.2** the causative agents produce infection and disease after they are inhaled. The primary pathological process is usually in the respiratory tract. The infection may ultimately manifest as a respiratory disease (e.g. diphtheria, tuberculosis) or as a nonrespiratory disease (smallpox, measles, leprosy). The air-borne or respiratory infections have four different modes of spread.

1. Direct droplet transmission: Droplets of sputum from nose and mouth of one person are projected directly on to the conjunctiva or into the nose and mouth of another person in close proximity during the acts of breathing, coughing, talking, laughing, or sneezing. This can happen upto a distance of one meter between two persons and takes place in case of agents having low viability, such as those of common cold and whooping cough.

2. Direct air-borne: Some droplets or droplet nuclei are inhaled with air directly as they remain suspended in the air and are carried by air currents over longer distance. Measles and chickenpox spread in this manner.

3. Indirect air-borne: Some large droplets fall on the clothes, cots or floor and remain there, making them secondary reservoirs of infection. When these droplets dry up, the pathogens are inhaled as such or along with dust during bed-making, dusting and sweeping. The agents may even be carried by air currents and inhaled later. Such transmission occurs in psittacosis, typhus fever, streptococcal sore throat and tuberculosis.

4. Contact transmission: It makes place directly by kissing and indirectly through contaminated food, milk, hands, surgical instruments and other fomites

when they are put in the mouth. Examples are streptococcal sore throat and diphtheria.

Respiratory infections account for the majority of illnesses in man all over the world, particularly in the young and the old. Their general methods of control are as follows:

- Killing the infective agent at source by appropriate therapy of the patients and carriers by antibiotics and chemotherapeutic drugs. This is done in case of diphtheria and cerebrospinal meningitis.
- Minimizing spread through air by the use of handkerchiefs and face masks, sterilization of air, proper ventilation, avoidance of overcrowding and by dust suppression (e.g. wet mopping of floors). Such methods are useful in diphtheria, tuberculosis, smallpox and other infections.
- Protecting susceptible persons in the community by specific immunization aimed at increasing host resistance as in case of diphtheria and whooping cough.

Water and Food-borne (Intestinal) Infections

These are infections **Table 15.3** that spread through contamination of water and food. Such contamination is usually fecal in nature. The infecting agent enters the body along with water and food, multiplies in intestines and is passed out in stools. When infected stools contaminate water, milk, food, hands or fomites, it leads to further spread of infection. Flies and dust can also provide a link between feces and food.

The infecting organism may not have its breeding ground in the intestine, and may not always enter by mouth or leave through anus in case of some worms. Hookworm infection enters through the skin instead of the mouth while guinea worm infection comes out of the skin and not the anus. Nonintestinal infections like poliomyelitis and infectious hepatitis also fall in this group because of their mode of spread.

CONTACT OR SURFACE INFECTIONS

In this group **Table 15.4** the infection comes out of the skin or mucous membrane of the patient and enters through the skin and mucous membrane of a healthy person through bodily or sex contact. The infection may also be carried indirectly through fomites, such as kaja

TABLE 15.3: Water and food-borne infections

Viral	Bacterial	Protozoal	Worms
Enterovirus infections	Cholera	Amoebiasis	Flukes
Infective hepatitis	Food poisoning	Giardiasis	Tapeworms
Poliomyelitis	Enteric fever	Balantidiasis	Trichinellosis
	Brucellosis		Threadworm
	Bacillary dysentery		Roundworm
	Diarrhea		Whipworm
			Hookworm
			Guinea worm

stick and handkerchief in case of trachoma, towels in case of gonorrheal vulvovaginitis and socks in case of ringworm.

Arthropod-borne Infections

Arthropods transmit disease agents **Table 15.5** in two ways.

- 1. As mechanical carriers:** When the infection is carried on the wings, legs, and mouth parts of flies, etc. Food and drinks become infected when flies sit on them. Cholera and some other water and food-borne diseases are spread in this manner.
- 2. As biological vectors:** When the disease agent develops or multiplies in the body of the vector. In many cases, vector is the definitive host while man is the intermediate host. The time passed by the agent in the vector's body is called 'extrinsic incubation period'. The vector is not infective during this period.

The agent may be transferred from arthropod to man by inoculation (e.g. mosquito bite), or by contamination of skin. Such contamination may occur through infective feces of the vector in case of housefly and through infected body fluids in case of louse when it gets crushed on the skin.

TABLE 15.4: Contact or surface infections

	Venereal	Nonvenereal
Viral	Lymphogranuloma inguinale	Trachoma
Spirochetal	Syphilis	Molluscum contagiosum
Bacterial	Gonorrhea	Yaws
	Soft chancre	Leprosy
	Donovaniasis or Granuloma inguinale	Erysipelas
		Impetigo
Fungal	Candidiasis	Ringworm
Protozoal	Trichomonas vaginalis infection	
Arthropods		Scabies

TABLE 15.5: Arthropod-borne infections

- **Flies**
 - Common housefly: Mechanical carrier of many infections, e.g. amebiasis, shigellosis, typhoid, trachoma, yaws
 - Sandfly: Leishmaniasis, (visceral and dermal), sandfly fever
 - Tsetse fly: African trypanosomiasis (sleeping sickness)
 - Blackfly: Onchocerciasis
- **Mosquitoes**
 - Anopheles: Malaria
 - Culex: Filariasis
 - *Aedes aegypti*: Yellow fever, dengue
- **Fleas:** Plague, endemic typhus
- **Louse:** Epidemic typhus, relapsing fever, trench fever
- **Bugs:** (Reduvid bug) Chagas' disease or American trypanosomiasis
- **Ticks:** Relapsing fever, typhus, kysanur forest disease (KFD)
- **Mites:** Typhus

Zoonoses

These are infections or infectious diseases transmissible under natural conditions from vertebrate animals to man. There are over 150 diseases common to man and animals. As per causative agents, they fall into 8 classes—viral, rickettsial, protozoal (psittacosis), bacterial, fungal, protozoal, helminthic and arthropod diseases. But as per mode of transmission they permeate in all the four groups mentioned earlier, as described below.

Airborne infection Anthrax, psittacosis, ornithosis.

Water and food-borne infections Man contracts them from animals through milk or meat. Examples are liver fluke, *T. solium*, *T. saginata*, intestinal tuberculosis, brucellosis and salmonellosis. Foot and mouth disease can also rarely occur in animal handlers.

Contact infections Glanders and some types of ringworm and scabies primarily found in animals.

Arthropod-borne infections: Plague, typhus, yellow fever and KFD.

In addition, some diseases are transmitted directly through bites of animals, e.g. Rabies and rat-bite fever. Still others have varied modes of transmission such as anthrax, leptospirosis, histoplasmosis and actinomycosis.

The zoonotic diseases which do not fit into a clear pattern as per the four modes of transmission mentioned above are described in the chapter on Miscellaneous Zoonoses.

Epidemiological Approach to Communicable Diseases after Natural Disasters

Natural disaster like flood, famine and earthquakes are usually associated with increased occurrence and even epidemics of communicable diseases. There are three ways in which an epidemic can be triggered by a disaster: by increasing transmission of local pathogens, by changing the receptivity of the population, or by introducing a new pathogen into the environment.

INCREASE IN TRANSMISSION

Disasters may increase the transmission of communicable diseases through three mechanisms.

1. An increase in promiscuity which often results when refugee camps are set up and become quickly overcrowded.
2. A deterioration in sanitary conditions in the environment. This deterioration can be caused by abrupt changes in the quantity and quality of the water supply and the creation of more favorable conditions for the proliferation of vectors. The vulnerability of the community, however, will be determined by the level of sanitation prior to the disaster.
3. A partial or total disruption of control programs, compounded by the tendency to divert available

material and human resources of health programs to improvised emergency programs (for example, immunization campaigns against typhoid) which are expensive and of uncertain benefit.

RECEPTIVITY OF THE POPULATION

The importance of the host-agent relationship cannot be overestimated. No further proof is needed than the synergism between malnutrition and infections. In famines, infectious diseases are the major immediate causes of death. However, while it is a fact that mortality from these diseases rises considerably, it is still a matter of controversy whether their incidence also increases. Paradoxically, natural sudden onset disasters, such as the cyclones in Bangladesh, have left behind a surviving population that is temporarily more resistant to communicable diseases. This resistance can be attributed to a selectively high mortality among the young, the very old and the sick.

INTRODUCTION OF A NEW PATHOGEN

Natural disasters may be associated with widespread massive migration of population over long distances, with the risk or introduction of new pathogens or new strains into areas of low prevalence or immunity.

Close epidemiological surveillance for communicable disease is essential in disaster situations. As a first step, the authorities should list in advance the diseases already under surveillance and should identify those which will need enhanced surveillance during the disaster. For this purpose, it must be ensured that reports are rapidly despatched to the control center on a daily basis.

Any unusual event detected by the surveillance system must be immediately investigated in order to determine its nature and magnitude and to take appropriate and specific control measures. In addition, unofficial rumours of epidemic outbreaks also must be officially investigated so that they may not nullify the benefits of surveillance. If such rumours are not investigated, there is risk of excessive or improper action by the highest authorities under public pressure.

DISEASE PREVENTION AND CONTROL IN EMERGENCIES

There are two major categories of measures to prevent and control diseases after disaster: sanitary measures and medical measures. Medical measures often have less long-term impact than sanitary measures and should not be undertaken without good reason. Vaccination campaigns are frequently resorted to in disaster situations, but new massive campaigns should not be encouraged. However, the emergency may provide the opportunity of extending normal immunization programs to people in the temporary disaster relief settlements and camps, who might earlier have been scattered and difficult to reach.

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Besides the commonly recognized respiratory infections, this chapter includes some infections that are not clinically recognized as such. Examples of such infections are chickenpox, smallpox and meningitis. The reason for their inclusion in this chapter is that these, as well as others described in this chapter, have the respiratory tract as the portal of entry or exit.

The viral and bacterial infections will be described separately and each type will be grouped into a non-specific and a specific group. This is followed by an account of acute respiratory infections in general and a description of the ARI Control Program. Detailed and systematic epidemiological description of an infective disease should follow the standard proforma given in Chapter 15. However, because of limitations of space, this will be done only in case of major infections. In specific infections, the source of infection is always exogenous, e.g. patients, carriers and animals. In nonspecific infections, the source may be exogenous or endogenous. When the source is endogenous, the preexisting infection becomes active due to lowered resistance and results in disease.

The following infections will be described in this chapter:

- Nonspecific viral infections
 - Common cold
 - Influenza
- Specific viral infections
 - Smallpox (Variola)
 - Chickenpox (Varicella)
 - Measles (Rubeola)
 - Mumps
 - German measles (Rubella)
- Nonspecific bacterial infections
 - Pneumonias
 - Streptococcal sore throat
- Specific bacterial infections
 - Diphtheria
 - Whooping cough
 - Meningococcal meningitis
 - Tuberculosis.

The above will be followed by a discussion of acute respiratory infections and the national ARI control program.

Nonspecific Viral Infections

Common Cold (Acute Coryza) (ICD-J00)

Among the acute respiratory illness two-thirds to three-fourths are caused by viruses. Most of these viral infections affect the upper respiratory tract, but lower respiratory tract can be involved in certain groups particularly in young age group and in certain epidemiological settings. The illness caused by respiratory viruses expressed into multiple distinct syndromes, such as common cold, pharyngitis, croup, tracheobronchitis, bronchiolitis, pneumonia, etc.

Almost everybody suffers from common cold sometime in his life. It occurs more in winter and in cold climates. It is an acute infection of the respiratory tract characterized by sneezing, running nose, nasopharyngeal irritation and malaise lasting two to seven days. Fever is rare. The infectious agent is a rhinovirus with more than 100 serotypes. The patient is highly infective 24 hours preceding and five days following the onset of the disease. Transmission is by droplet method or through fomites such as handkerchief. Susceptibility is general. Immunity is short-lived and lasts for a month or so. Incubation period is 12 to 72 (usually 24) hours.

There is no specific treatment. Cold vaccines have been used but the results are not encouraging.

Influenza (ICD-J11.1)

Influenza is an acute infectious respiratory disease caused by RNA viruses of the family orthomyxoviridae (the influenza viruses). The influenza virus, known to be circulating as a human pathogen since at least the 16th century is notable for its unique ability to cause recurrent epidemics and global pandemics. Genetic reassortments in the influenza virus cause fast and unpredictable antigenic changes in important immune targets leading to recurrent epidemics of febrile respiratory disease every one to three years. Each century has seen some pandemics rapidly progressing to all parts of the world due to emergence of a novel virus to which the overall population holds no immunity.

CLINICAL FEATURES

Infection with influenza may be asymptomatic but usually gives rise to fever and typical prostrating disease, characteristic in epidemics. Usual symptoms are flushed face, congested conjunctivae, cough, sore throat, fever for two to three days, headache, myalgia, back pains and marked weakness. Pneumonia due to secondary bacterial infection is the most common complication.

Laboratory confirmation is made by recovery of virus from throat washings or by demonstration of significant rise of influenza antibodies in the serum in acute and convalescent stages of the disease or by direct identification of the virus in nasopharyngeal cells.

EPIDEMIOLOGY

A large number of cases are either missed or are unreported because of their mildness. Hence exact incidence cannot be assessed. Morbidity rate varies from 15 to 25 percent of the population exposed to risk in case of large communities. The rate may be as high as 40 percent in case of closed populations.¹ Once an epidemic starts, its peak is reached in three to four weeks before declining.²

The disease was first recognized in 1173; since then 80 epidemics have occurred. The epidemic lasts for six to eight weeks at a place. It is not known what happens to the virus between the epidemics.³ However, there is evidence that transmission of the virus to extrahuman reservoirs (pigs, horses, birds, ducks) keeps the virus cycle alive.⁴

CHANGING NATURE OF VIRUS

New influenza virus strain may evolve due to point mutation or by genetic reassortment. Two type of antigenic change may occur in the virus namely *antigenic drift* and *shift*. Minor changes in the hemagglutinin and/or neuraminidase antigens on the surface of the virus which results from point mutation during viral replication is called antigenic drift. Antigenic drift occurs in both Influenza A and B viruses. Influenza B viruses undergo antigenic drift less rapidly than influenza A viruses. Drift ensures an ongoing turnover of viral strains and thus a constant renewal of susceptible hosts, which is the basis for the regular occurrence of influenza epidemics. Antigenic drift explains why a person can be infected by Influenza A viruses several times and also why Influenza vaccine need to be updated every year.

Antigenic shift is the major antigenic change that results from genetic reassortment between two different virus subtypes coinfecting the same cell and developing a new subtype with completely new hemagglutinin and *neuraminidase* antigen. Antigenic shift is noted only with type A influenza virus. Antigenic shift appear to result from genetic reassortment between human strains and avian or animal strains. An example of antigenic shift

involving both the hemagglutinin and *neuraminidase* is that of 1957 influenza pandemic, when predominant sub type of influenza A shifted from H1N1 to H2N2. The population has got no immunity against the newly emerged strain, which can then spread to cause an 'Influenza pandemic'. Pandemics occur every 10 to 50 years. They have been documented since the 16th century and in the last 400 years; at least 31 pandemics have been recorded. During the twentieth century, three influenza pandemics occurred (**Table 16.1**).

CHARACTERISTICS OF INFLUENZA PANDEMICS

- Occurrence outside the usual season
- Extremely rapid transmission with concurrent outbreaks throughout the globe
- High attack rates in all age groups with high mortality rates even in young adults.

CAUSATIVE AGENT

Influenza viruses are RNA viruses of orthomyxoviridae family. The virus has three distinct genera (types A, B or C) based on antigenic differences of their nucleo and matrix proteins. Influenza A viruses are divided into subtypes based on two proteins on the surface of the virus: the hemagglutinin (H) and the neuraminidase (N). Influenza B viruses are not categorized into subtypes. Currently among many subtypes of viruses, influenza A (H1N1) viruses, influenza A (H3N2) viruses, and influenza B viruses are circulating worldwide in human. Epidemics are primarily caused by type A viruses and occasionally by type B in human being. Type C influenza virus has been associated with sporadic cases and minor localized outbreaks. Avian influenza viruses (AIV) belong to type A influenza virus.

HOST FACTORS

Age and sex: As mentioned earlier, the influenza virus maximally attacks those in the age group 5 to 15 years but no age group or sex is spared. Rates of infection are highest among children, but death and serious illness are common amongst persons aged 65 years, children below two years and persons of any age with associated medical conditions that place them at increased risk for complications from influenza.

TABLE 16.1: Antigenic Shifts and Pandemics

Year	Designation	Resulting pandemic
1892	H3N2	Moderate
1918	H1N1 ("Spanish")	Devastating
1957	H2N2 ("Asian")	Moderate
1968	H3N2 ("Hong Kong")	Mild

Source: Pandemic Influenza, C D Alert, May-June 2006 Vol.10: No.5 to 6, Directorate General of Health Services, Government of India

Immunity: The antibody to H type of antigen prevents initiation of the infection while that to N antigen prevents virus release and spread. The antibodies developed in the respiratory tract following an infection are mostly IgA. They appear in about seven days after an attack and peak in the blood by two weeks. The level drops to preinfection level by 8 to 12 months.

Antibody against one influenza virus type or subtype confers limited or no protection against another type or subtype of influenza. Furthermore, antibody to one antigenic variant of influenza virus might not completely protect against a new antigenic variant of the same type or subtype. Frequent development of antigenic variants through antigenic drift is the virologic basis for seasonal epidemics and the reason for the usual incorporation of one or more new strains in each year's influenza vaccine.

MODE OF TRANSMISSION

Influenza viruses predominantly transmitted through respiratory droplets of coughs and sneezes from an infected person. Influenza viruses may also spread through direct (skin to skin) or indirect contact with infected material, which ultimately enter through nasopharyngeal route. Transmission of viruses starts one day before the onset of symptoms and continue up to five to seven days after the symptoms subsides. Transmission is possible from asymptomatic carriers. Children may pass the virus for longer than seven days. Influenza viruses can be inactivated by sunlight, disinfectants and detergents easily. Frequent hand washing reduces the risk of infection.

TRANSMISSION OF INFLUENZA VIRUSES FROM ANIMALS TO PEOPLE

Influenza A viruses are found in many different animals, including ducks, chickens, pigs, whales, horses and seals. Wild birds are the primary natural reservoir for all subtypes of influenza A viruses and are thought to be the source of influenza A viruses in all other animals. Pigs can be infected with human, avian and swine influenza viruses and there is possibility of development of new strain due to genetic reassortment among the viruses of different species. While it is unusual for people to get influenza infections directly from animals, sporadic human infections and outbreaks caused by certain avian influenza A viruses have been reported.

Incubation Period

The incubation time for influenza ranges from one to five days with an average of two days.

Diagnosis

Traditionally, the definitive diagnosis of influenza is made either on the basis of virus isolation or by serology. Virus

is most frequently isolated from nasopharyngeal or throat swabs, nasal washings or sputum obtained within three days of onset of illness. Number of tests can help in confirming the diagnosis of influenza. During an outbreak of respiratory illness, however, testing can be very helpful in determining if influenza is the cause of the outbreak. Following laboratory tests that can be carried out are:

- Detection of antigen in nasal secretions by:
 - Rapid test: It can be used to detect influenza viruses within 30 minutes.
 - Immunofluorescence test
 - Antigen capture ELISA with monoclonal antibody to the nucleoprotein
 - Reverse Transcriptase Polymerase Chain Reaction (RT-PCR)
- Virus isolation:
 - Cell line Madin-Darby Canine Kidneycells (MDCK)
 - Egg inoculation
- Serological test in paired serum samples

THREAT FROM AVIAN INFLUENZA

Bird flu is a contagious disease of animals caused by viruses that normally infects only birds and less commonly pigs. Avian influenza is very species specific, but has on rare occasions crossed the species barrier to infect humans. The disease can presents in two extremes of pathogenicity, the milder one may even go unnoticed while the highly pathogenic form may even cause mortality of 100 percent of birds within 48 hours. Of the 16 "H" subtypes only five and seven are known to cause disease of high pathogenicity. They are introduced in the poultry flocks as of low pathogenicity but, if given sufficient time to circulate, can mutate to become highly infective. This is the reason why presence of H5 and H7 virus in poultry is always a cause of concern, even when the initial signs of infection are mild.

The current outbreak of highly infective avian influenza which began in S E Asia in mid-2003, are the largest and most severe on record. Never before in the histories of this disease have so many countries been simultaneously affected resulting in death of so many birds (150 million). The causative agent, H5N1 virus is now considered endemic in many parts of Asia. The widespread persistence of H5N1 virus in poultry population poses two main risks for human health; first is the risk of direct transmission from poultry to humans resulting in very severe disease leading to high mortality. Alarmingly most cases have occurred in the previously healthy children and young adults. A second risk of even greater concern is that the virus may change highly infectious form for humans and spreads easily from person to person. Such a change would mark the beginning of a global pandemic.

TRANSMISSION

Direct contact is presently considered as the main route of transmission while come in contact with infected bird (slaughter, defeathering, butchering and preparation of poultry for cooking, etc.). Infections also occur from virus in their feces and the environmental exposure to such dropping.

The virus can improve its transmissibility among humans via two principal mechanisms. The first is a “re-assortment” event in which the genetic material is exchanged between human and avian viruses during co-infection of a human or pig resulting in emergence of a fully transmissible pandemic virus. Other mechanism is the adaptive mutation increasing the capacity of the virus to bind to human cells. Besides that many birds are seen as “silent carriers” of the disease and the virus seems to withstand the adversities better than their earlier strains. It is important to note that, vaccine produced each for seasonal influenza will not protect men from avian influenza.

CONTROL OF INFLUENZA

Influenza vaccination is the key strategy for the prevention of influenza during the interpandemic periods and a pillar of pandemic preparedness. Antiviral drugs can only be used as an adjunct. Resistant mutants of both the classes of antiviral agents have been detected.

TYPES OF INFLUENZA VACCINES

The vaccines are of following types:

- Whole virus vaccines consisting of inactivated viruses
- Split vaccines: This vaccines consisting of virus particles disrupted by detergent treatment. HA and NA antigens are anchored in small fragments of viral membrane.
- Subunit vaccines: Only the NA and HA proteins are present and other internal and matrix proteins are removed.
- Virosomal or adjuvanted vaccines: The HA and NA antigens are carried by an oil-in-water (liposome) like particle.
- Intranasal vaccine: An intranasal, trivalent, live-attenuated influenza vaccine (LAIV) indicated for healthy persons aged 5 to 49 years.

The justification for vaccine use: During influenza outbreaks, appropriate vaccination may significantly reduce respiratory illness and sick leave among healthy adults. More importantly, vaccination may reduce severe disease and premature death in the elderly and in persons with underlying ailments or disease. As the viruses undergo frequent antigenic changes, new vaccines must be designed to match the circulating strains that are most likely to cause the next epidemic. WHO has established a Global Influenza Surveillance Network

to suggest the composition influenza vaccine. Currently, two subtypes of influenza A (A/H1N1 and A/H3N2) virus as well as influenza B virus are included in the vaccine. Among healthy adults, appropriate influenza vaccines will in general achieve protection rates of about 50 to 80 percent against clinical disease, whereas vaccination of the elderly reduces the risk of serious complications or death by 70 to 85 percent.

Route and dose: Most inactivated influenza vaccines are given via the intramuscular route in the deltoid muscle, except in infants where the recommended site is the antero-lateral aspect of the thigh. A single dose of inactivated vaccine annually is appropriate, except for previously unvaccinated preschool children pre-existing with medical conditions who should receive two doses at least one month apart. The usual dose is 0.5 ml except in case of children, where the dose should be half. Seroprotection is usually obtained within two to three weeks and the post-vaccination immunity lasts for about 6 to 12 months.

WHO RECOMMENDS THE FOLLOWING PRIORITY CASES FOR VACCINATION

- Elderly noninstitutionalized individuals suffering from chronic conditions such as Pulmonary or Cardiovascular disease, metabolic illness including diabetes mellitus and renal dysfunction, various types of immunosuppression including persons with AIDS and transplant recipients.
- All adults and children aged over six months suffering from any of the conditions mentioned above.
- Health care persons in regular and frequent contact with high risk persons.
- Household contacts of high-risk persons including elderly and the disabled.
- Pregnant women who will be in their second or third trimester by the start of the influenza season.

When adequate vaccine supplies are available, vaccination of general public may be considered.

Treatment: 1. Antibiotics for bacterial complications of influenza 2. Antiviral therapy 3. Management of contacts may include-antiviral prophylaxis and advice about relevant vaccination (e.g. pandemic strain vaccine if available).

Prevention and control strategies: People with respiratory infection symptoms should practice the following respiratory etiquette. All symptomatic people should: 1. Avoid close contact (less than 1 meter) with other people. 2. Cover their nose and mouth when coughing or sneezing. 3. Use disposable tissues to contain respiratory secretions. 4. Immediately dispose off used tissues.

Social distancing: 1. Crowded places and large gatherings of people should be avoided at the time of an influenza pandemic, whether such gatherings are in

open or closed spaces. 2. A distance of at least 1 meter should be maintained between persons wherever possible. 3. Any form of contact with people who are unwell with pandemic influenza, including visitors, should be avoided wherever practicable. 4. Movement of people in and out of the area will be effectively restricted to prevent further spread to unaffected areas.

RECOMMENDED DRUGS AND DOSAGE FOR PROPHYLAXIS OF INFLUENZA

- Amantadine 5 mg/kg/day up to 10 mg/kg/day
- Rimantadine
- Oseltamivir
- Zanamivir

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H1N1 Influenza (Swine Flu)

A novel influenza A H1N1 virus got noticed in Mexico in April 2009, which is quite different from the circulating seasonal influenza viruses. On 11th June 2009, WHO declared this as a pandemic.¹

Influenza A virus infection is found in humans, swine, bird, horse and aquatic mammals like seal, whale etc. Influenza B and C type virus infections are found only in human and in no other species of animal. Occasionally human influenza A infects Pig and vice-versa, but does not infect bird. Bird influenza A also infects pig, but not man. Further, when human and bird viruses infect pig simultaneously, then mixing of human and bird gene occurs (antigenic shift), leading to an absolutely new hybrid virus. In such situations a big epidemic of influenza is expected, as because the human population has no antibody to these new viral agents.

Swine Flu is a respiratory disease of pigs caused by influenza type A virus, and regular outbreaks occur throughout the World in Pigs. It causes high illness with low mortality in pigs.

H1N1 INFLUENZA IN PIGS

Transmission from pig to pig occurs directly by droplet infection of respiratory secretions and through contaminated articles used in piggeries. The illness in pigs is characterized by sudden onset of fever,

depression, coughing (barking), copious discharge from nose and eyes. Recovery occurs within six to eight days and mortality is low. An effective vaccine is available against highly prevalent H1N1 and H3N2 pig viruses that is used in Pig Industries

H1N1 INFLUENZA IN HUMANS

Transmission in Human

- Direct transmission through droplet infection from direct exposure of infected pigs (close contact to sick animals in market places or workers of swine industry).
- Person to person transmission (droplet infection) occurs through sneezing and coughing from swine flu infected patients.

Swine flu is not transmitted by eating cooked pork or pork products. Like many other viruses it is easily killed during cooking at a temperature of 160°F.

Illness in Human

After a short incubation period of two to three days, a person suddenly develops high fever, running nose, sore throat, coughing, respiratory distress and some time nausea, vomiting and diarrhea. Death is very rare due to primary or secondary pneumonia.

Majority of the human cases of swine influenza are mild and self limited and do not require hospitalization. Swine influenza occurs in relatively younger population and severe illness and death is found in cases with underlying medical conditions.

Persons who are currently diagnosed with the following conditions must take extra precautions against the H1N1 flu (Swine Flu) as they are more vulnerable to the infection.²

- Chronic respiratory disease (Bronchial asthma, Chronic bronchitis, Chronic Obstructive Airway Diseases and Bronchiectasis)
- Heart diseases
- Chronic renal disease
- Hypertension
- Diabetes
- Patients with immunodeficiency (HIV)
- Pregnant women

Children and those above 60 years too, should take extra care against the H1N1 flu (Swine Flu).

Seeking medical help at a nearby designated hospital or its OPD screening centre in the early stages of flu like symptoms such as fever, body ache, running nose, cough and sore throat, difficulty in breathing can prevent further complications.

If more than three or four people having similar symptoms are found in one locality, then inform toll free number at 1075 or 1800-11-4377. For further clarifications another national help line has been set 011-23921401.

Diagnosis

Respiratory specimens (nasal swab, throat swab or gurgling and blood sample) need to be collected within four to six days of illness (maximum virus shedding period) and is tested by CDC (Atlanta, USA) kits by PCR technique. Virus may also be isolated in tissue culture or embryonated egg culture, where the isolates may be assessed by HAI serological test.

Treatment

The virus is sensitive to antiviral Oseltamivir (Tamiflu). Dose is 75 mg twice a day for five days, the dose and duration may be prolonged as needed, but not exceeding 300 mg a day for serious side effects. Antibiotics are only reserved for secondary bacterial pneumonia.

Control Measures

Suspected cases are quarantined till laboratory reports are available. Each patient should cover mouth and nose with a surgical mask. Hospital staff should also use mask and strictly follow hand hygiene procedures in handling the cases. In caring patients at home, house members should also follow these procedures. Oseltamivir can also be used as prophylaxis, the dose being 75 mg once daily for five to seven days. Vaccination is recommended for high risk groups like health worker and laboratory staff.

Vaccine¹

PANENZA, is a split virus inactivated, nonadjuvanted monovalent vaccine against pandemic influenza. The vaccine contains antigen equivalent to A/California/7/2009 (H1N1)v like strain (NYMC X-179A) – 15 micrograms per 0.5 ml. The other ingredients are thiomersal, sodium chloride, potassium chloride, disodium phosphate dehydrate, potassium dihydrogen phosphate and water. PANENZA is supplied in a multidose vial (10 doses of 0.5 ml). The suspension is a colorless liquid, clear to opalescent. 0.5 ml is administered intramuscularly. The vaccine is stored at 2 to 8°C; it is never kept in freezer compartment. After opening the vial the vaccine can be given within seven days, provided stored at 2 to 8°C. Common side effects of PANENZA are headache, muscular pain, and pain at the injection site.

In the first phase, the health workers in the hospitals, community health center and above would be targeted. Subsequently remaining health workers and emergency service providers would be taken up.

Contraindications of PANENZA: History of sudden life threatening allergic reaction to any ingredient of PANENZA or to any of the substances that may be present in trace amounts such as egg and chick protein, etc.

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Specific Viral Infections

Smallpox (*Variola*) (ICD-BO3)

Smallpox has been one of the greatest scourges and a major killer of mankind. Till the discovery of vaccination, smallpox was responsible for the death of one out of every five children below five years of age. Thanks to global effort coordinated by the WHO, smallpox no longer exists. India's last indigenous case occurred on 17, May 1975 in Bihar. In October 1979, the WHO certified that smallpox had been eradicated from the world. This was confirmed by the World Health Assembly on 8th May 1980.¹ In this context, the occurrence of a single case of smallpox anywhere in the world would constitute an epidemiological emergency. An account of smallpox, now extinct, follows. This is being given so that public health physicians may diagnose a patient in case of reappearance of smallpox.

CLINICAL FEATURES

According to WHO, smallpox cases are classified into two groups.

Variola Major

It is defined as typical smallpox with case fatality rate ranging from 20 to 50 percent depending on different host and environment factors. It has five subtypes:

1. Ordinary or classical smallpox
2. Modified smallpox
3. Hemorrhagic smallpox
4. Flat type of smallpox
5. *Variola sine eruption.*

The above varieties are not described here further. Details can be found in the older texts. The relative incidence of various types in an epidemic is as follows: ordinary 82 percent, modified 15 percent, hemorrhagic 2.7 percent, flat 0.3 percent. The fifth subtype is very rare. The differentiating features of smallpox and chickenpox are given in **Table 16.2**.

Variola Minor or Benign Type (Alastrim)

It is a milder form of infection with short duration. It may be mistaken for chickenpox. Mortality is one percent or less. No distinction should be made between *variola major* and *variola minor* from epidemiological point of view.

TABLE 16.2: Differences between smallpox and chickenpox

Characteristics	Smallpox	Chickenpox
Incubation period	7-17 days, average 12	7-12 days, average 15
Fever	For 2-3 days at the onset and again when pustules appear	One day at the onset rising with each fresh crop of lesions
Prodromal symptoms	Severe	Mild
Rash		
• Distribution	First on periphery and then towards center, (centrifugal) <ul style="list-style-type: none"> – Palms and soles affected – Axilla and groin spared – Predominant on extensor surfaces and bony prominences 	First on trunk and then towards periphery, (centripetal) <ul style="list-style-type: none"> – Spared – Affected – Mostly on flexor surfaces
• Appearance and progress	Appears on 3rd day and progresses in stages	Appears on 1st day and comes in crops
• Lesions	<ul style="list-style-type: none"> – Shotty, deep seated, multilocular, – Pustules 1 cm or more in size, round and spherical, may be confluent; show umbilication 	<ul style="list-style-type: none"> – Superficial, unilocular, surrounded – Small, elliptical, mostly discrete; no umbilication
• Evolution	<ul style="list-style-type: none"> – Slow, deliberate and majestic, passing through the stages of macule, papule, pustule – Scabs form 10-14 days after the appearance of rash 	<ul style="list-style-type: none"> – Very rapid – Form 4-7 days after the rash appears
Sequelae	Disfiguration, blindness and death common. Leaves pitted scars	Residual sequelae rare. Leaves only pink stains but not permanent or pitted scars

LABORATORY DIAGNOSIS

This is confirmed by:

- Tissue culture
- Serological examination
- Electron microscopy

EPIDEMIOLOGICAL BASIS FOR SMALLPOX ERADICATION

It is often wondered how smallpox could be eradicated while other major infections like malaria, leprosy, tetanus, tuberculosis, polio, viral hepatitis, cholera, sexually transmitted diseases, filariasis and rabies are still rampant despite sustained efforts at their control. The reason lies in the unique combination of certain characteristics in relation to smallpox. These characteristics are listed below:

- Absence of an animal reservoir of the causative agent
- Absence of human carrier stage
- Absence of subclinical cases
- Rarity of second attacks
- Easy detection of disease, even by a layman
- Slow transmission, which allows time to contain an outbreak
- Availability of a stable, potent effective vaccine
- International cooperation.

VACCINATION—THE CURRENT STATUS

The 34th WHO Assembly amended the International Health Regulations to delete all references to smallpox and smallpox vaccination. Only those at special risk, viz. vaccine handlers and researchers on related orthopox-

viruses, such as monkeypox virus, should receive smallpox vaccination.

SAFETY OF SMALLPOX VACCINATION

Adverse effects consistently reported have included myopericarditis at frequencies that exceeded what might occur by coincidence. The committee has noted the importance for smallpox immunization programs to be supported by adverse event monitoring and recognizes that data are insufficient to define the incidence of adverse events among primary vaccinees as opposed to individuals revaccinated after a long interval.¹

CURRENT STATUS OF POXVIRUS DISEASE

- *Accidental infection:* Two WHO collaborating centers at Moscow in Russia and Atlanta in USA maintain stock not only of smallpox viruses but also other poxviruses like monkeypox, cowpox, camelpox, tarapox and tateropox. Risk of accidental laboratory infection is always there.²⁻⁴
- *Infections by animal poxviruses:* Apart from accidental infection in the laboratories, animal poxvirus infections have become a cause of considerable concern during recent years.
 - *Tarapox:*⁵ The clinical disease in man by this unclassified poxvirus is characterized by fever and one to two pustular lesions lasting up to six weeks. It is a zoonotic infection found in the wild and domestic animals of East and Central Africa with transmission to man by mosquitoes. Smallpox vaccination cannot protect against this disease.

- *Human monkeypox*: A zoonotic infection found sporadically in the tropical rain forests of West and Central Africa, human monkeypox was first recognised as a human disease in Zaire (Congo) in 1970. Since then, 165 cases have been reported to WHO, of which 148 are from Zaire.⁶ Belonging to the orthopoxvirus group, reservoir hosts are not known and man is an incidental host with an incubation period of about 14 days.⁷ Clinically the disease is similar to smallpox. Rash can be extensive with considerable mortality, especially in children. Secondary attack rate is 15 percent compared to 30 to 45 percent in case of smallpox.⁶ Smallpox vaccination protects against monkeypox. With the vaccination status of smallpox going down, increase in the occurrence of human monkeypox can be expected. WHO surveillance in West and Central Africa continues for the disease.

Now that smallpox has been eradicated from the world, there are still some questions to which there is no clear answer. These questions relate to the following aspects:

- Can any other orthopoxvirus undergo genetic transformation to smallpox?
- Are there animal reservoirs of smallpox or smallpox like viruses which were hitherto unknown?
- Can we ensure safe laboratories devoid of accidents of the kind that occurred in 1978 at Birmingham?
- Can other poxviruses replace smallpox virus as a widespread disease?
- Can smallpox virus be used as a weapon for biological warfare?

While the above questions are being debated, the WHO is taking no chances. As a precaution against any future outbreak of smallpox, stocks of smallpox vaccine which provides cross-immunity to some of the other poxvirus diseases, bifurcated vaccination needles and vaccine for nearly 30 crore people are being maintained by the WHO at Geneva, New Delhi and Toronto.⁸

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Chickenpox (Varicella) (ICD-B01.9)

CLINICAL PICTURE

Chickenpox is important because it is mistaken with a more dangerous disease, i.e. modified smallpox. Symptoms and signs of the two have already been compared. Chickenpox is a mild disease but varies in intensity. There may be just one to two pocks or the disease may take serious and fatal, though rare, forms such as varicella bullosa, v. gangrenosa and v. hemorrhagica. Encephalitis and pneumonia are rare complications.

Breakthrough Varicella

In previously immunized children asymptomatic infection with wild type of virus may occur. When a child develops rash after 42 days of chickenpox vaccination and is due to wild type of Varicella-Zoster virus, is known as breakthrough varicella. This breakthrough varicella should be isolated, since they are infectious.¹

Progressive Varicella

Progressive varicella is one of the worst complications of primary Varicella-Zoster virus infection, characterized by severe hemorrhage, coagulopathy and continued development of lesions. Immunocompromised children, pregnant women and newborns are most susceptible.¹

Congenital Varicella Syndrome

Congenital Varicella Syndrome develops among two percent of fetuses whose mothers had varicella within first 20 weeks of pregnancy. Limb development is hampered when fetus is infected at 6 to 12 weeks of gestation. Eye and brain development is interrupted, when infection at 16 to 20 weeks of gestation. Horner syndrome and dysfunction of the urethral or anal sphincters may be developed due to viral damage of the sympathetic fibers in the cervical and lumbosacral cord. The stigmata involve mainly the skin, extremities, eyes, and brain. The characteristic cutaneous lesion has been called a cicatrix, a zig-zag scarring. The diagnosis of VZV fetopathy is based mainly on the history of gestational chickenpox combined with the stigmata seen in the fetus. Antiviral treatment of infants with congenital VZV syndrome is not indicated.^{1,2}

DIAGNOSIS

- Clinical
- Blood
 - At first leucopenia for first 72 hours; followed by a relative and absolute lymphocytosis.
 - VZV immunoglobulin G (IgG) antibodies can be detected by several methods and a 4-fold rise in IgG antibodies is also confirmatory of acute infection.

- CSF: Mild lymphocytic pleocytosis and increase in protein in the cerebrospinal fluid; glucose concentration being normal.
- Direct fluorescence assay (DFA) from skin lesions, polymerase chain reaction (PCR) and Tzanck smear or Calcofluor stain to detect multinucleated giant cells.

TREATMENT

Oral therapy with acyclovir (20 mg/kg/dose; maximum: 800 mg/dose) given as four doses per day for five days is the drug of choice. In healthy adults, acyclovir 800 mg is given five times a day orally for five days. Immunocompromised patients benefit from both symptomatic and antiviral therapy. Oral acyclovir administered late in the incubation period may modify subsequent varicella in the normal child. However, its use in this manner is not recommended until it can be further evaluated. When acyclovir resistance is seen then foscarnet is used.

COMPLICATIONS

The complications are more commonly seen in immunocompromised patients. These are mild thrombocytopenia, purpura, hemorrhagic vesicles, hematuria and gastrointestinal bleeding. Cerebellar ataxia, encephalitis, pneumonia, nephritis, nephrotic syndrome, hemolytic-uremic syndrome, arthritis, myocarditis, pericarditis, pancreatitis, and orchitis. Secondary bacterial infections, with group A—hemolytic streptococci and *Staphylococcus aureus*, are common. Cellulitis, erysipelas, osteomyelitis, and rarely meningitis are observed. Pitted scars are frequent sequelae. Among AIDS patients Varicella-Zoster virus causes acute retinal necrosis and progressive outer retinal necrosis.³⁻⁵

EPIDEMIOLOGY

Chickenpox is as old as smallpox. It occurs all over the world and may affect almost everybody, but children under ten years are most susceptible. Immunity after an attack is long lived, may be for life.

Chickenpox is a relatively mild disease in healthy children but may be life threatening in immunosuppressed patients, neonates, and normal adults, especially smokers—for whom the risk of varicella pneumonia is high. The epidemiology of chickenpox appears to be changing: There has been an unexplained upward shift in the age distribution of cases over the last 20 years.⁶

Chickenpox is caused by a filterable virus called the Varicella-Zoster virus which is also responsible for herpes zoster. These two diseases are now regarded as manifestations of different host responses to the same etiological agent. Herpes zoster or shingles is a localized form

of varicella and may precede or follow it. It may thus occur as fresh infection or as reactivated old infection. Vesicles are restricted to skin areas supplied by sensory nerves from a single dorsal ganglion or a group of ganglia. Lesions appear on the nerve pathways in groups on one side of the body only. Herpes zoster is more common in adults and is rare in children.

Chickenpox is transmitted like smallpox except that the crusts are noninfective. An individual is usually infective for one week starting from one to two days before the appearance of rash to four to five days thereafter. Chickenpox is a highly contagious disease and can cause a secondary attack rate up to 90 percent in household contacts. *Incubation period* is 7 to 21 days, average 14 to 16 days.

PREVENTION

Passive Immunization

Varicella-zoster immune globulin (VZIG) post exposure prophylaxis is recommended for immunocompromised children, pregnant women, and newborns exposed to maternal varicella. Close contact between a susceptible high-risk patient and a patient with herpes zoster is also an indication for VZIG prophylaxis.³ If available, Varicella-Zoster immunoglobulin (VZIG) in a dose of 15 to 20 units/kg body weight should be administered as a 16.5 percent solution by intramuscular route within 72 hours of exposure, when it is effective in preventing the disease or modifying it.^{7,8} If it is not available, human immunoglobulin (IG) given promptly in a dose of 0.6 to 1.2 ml/kg of body weight may also be effective.⁹

Active Immunization

Vaccine given to normal children within three to five days exposure is effective in preventing or modifying varicella. Varicella vaccine is now recommended for postexposure use, for outbreak control. Live virus vaccine is recommended for routine administration in children at 12 to 18 months of age.¹⁰ Children 12 months to 12 years receive a single vaccine dose; adolescents and adults require two vaccine doses, a minimum of four weeks apart.¹¹ Tetravalent combined measles, mumps, rubella, and varicella vaccine (MMRV) has also been investigated.¹² *Contraindications:* Children with cell-mediated immune deficiencies. *Interactions:* Varicella vaccine if given within four weeks of MMR vaccine is associated with a higher risk of breakthrough disease; therefore, it is recommended that the vaccines either be administered simultaneously at different sites or be given at least four weeks apart. IAP has recommended varicella vaccine to children only after one to one discussion with parents.¹³ The potential danger of such vaccination is a latent infection with herpes zoster in later life.¹⁴

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Measles (*Rubeola; Morbilli*) (ICD-B05.9)

CLINICAL PICTURE

In measles, the capillaries in the skin and the respiratory mucous membrane react to the invading virus. Onset is sudden (Pre-eruptive stage) with cold, catarrh, conjunctivitis and fever 37.8°C to 38.9°C on the first day. Fever comes down but reappears with rash. Koplik's spots appear on the second day as minute bluish white pin point dots with red areola opposite first lower molar teeth, on the innerside of both the cheeks. They disappear on the third or fourth day. Koplik's spot may be rarely found within the midportion of the lower lip, on the palate and on the lacrimal caruncle.

Rash (eruptive stage) appears on the fourth day as dark red macules or maculopapular granules, first evident behind the ears and at the junction of scalp and forehead and then spreading over the face, trunk and limbs in a few hours.

The rash lasts for four to six days. Leucopenia is usual. Certain variants of rash may sometimes be seen.

These are:

- Morbillis—Exanthem or the usual skin rash is absent. Only the enanthem (lesions on mucous membrane) is seen.
- Forme fruste—Mild, abortive, discrete exanthem.
- Hemorrhagic—Raised, velvety lesions with hemorrhages in rash and other parts; most toxic and fatal form.

Case Definitions of Clinical Measles¹

Suspect (history): Any case with fever and rash.

Probable (history and clinical examination): Any person with fever and maculopapular rash (i.e. non-vesicular or without fluid) lasting for more than three days and cough or coryza (running nose) or conjunctivitis (red eyes).

For the purpose of epidemiological investigation, a clinically diagnosed measles case would be a case which has occurred within last three months.

Laboratory confirmed measles: A case that meets the clinical case definition and presence of measles specific IgM antibodies in the serum, or at least fourfold increase in antibody titer or isolation of measles virus.

Epidemiologically linked measles: A case that meets the clinical case definition and is linked epidemiologically to a laboratory confirmed case.

COMPLICATIONS

Most persons recover from measles without sequelae. Complications are more common among children less than five years and adults above 20 years of age. Among children less than five years of age, frequent measles complications include otitis media (5–15%) and pneumonia (5–10%). In developing countries, persistent diarrhea with protein losing enteropathy may occur in young infants. Severe form of disease, including bleeding from skin and mucosa may occur (Black measles). Encephalitis may also occur occasionally, the incidence being 1 in 1000 cases, with case fatality of 10 to 30 percent. The encephalitis is probably an allergic reaction of brain tissue to measles virus.² In rare instances, subacute sclerosing panencephalitis (SSPE) may develop in persons who have had measles three to seven years ago. The incidence is about seven cases per million cases of measles.³ Malnutrition, especially vitamin A deficiency, severe immunological disorders such as advanced HIV infection are some known factors for development of severe and fatal measles. Broncho-pneumonia occurs almost invariably in malnourished children. Mortality in such children may be 400 times higher than that in well nourished children.⁴

Diagnosis of Measles⁵

- Clinical examination.
- Blood: Single serum IgM antibody at 4 to 28 days post rash onset. Their presence provides strong

evidence of current or recent measles infection. IgM is also produced on primary vaccination, but it may decline more rapidly than in IgM produced in response to wild virus. Vaccine and wild virus IgM can not be distinguished by serological tests – vaccination history is therefore essential for interpretation of test results. ELISA test for measles-specific IgM antibodies is recommended for the WHO measles laboratory network. All measles negative sera should be further tested for rubella specific IgM antibodies.

- Urine: Virus isolation at zero to five days post rash. For epidemiological investigation, clinical measles would be a case within last three months.

Case Management of Measles

Case management depends upon severity of disease.

Uncomplicated measles: Child with measles and absence of signs and symptoms of complicated or severe disease. This children requires supportive measures like (i) Vitamin A oil is given to all children, (ii) Breastfeeding is continued along with complementary feeding or fluids as usual, green leafy vegetables, yellow fruits, etc. (iii) ORS given in case of diarrhea, fever is treated with paracetamol to reduce risk of convulsion.

Complicated measles: Same as mentioned in uncomplicated measles. In addition eye lesions are cleaned and treated with one percent tetracycline eye ointment three times a day for seven days. Ear discharges are cleaned and treated with antibiotics. Pneumonia is also treated. The patient is referred to a health facility for further management (**Table 16.3**).

EPIDEMIOLOGY

Measles is endemic all over the world. Almost all people suffer from it once. It occurs in epidemic form every 2-3 years, more in winter months from December to April. Measles is a leading cause of childhood morbidity and mortality and nearly half the global burden of vaccine preventable deaths. In India measles is the biggest cause of vaccine-preventable mortality and morbidity. Measles predominantly affects children under five years of age (>50% in India).

TABLE 16.3: Recommended vitamin A schedule and dosage for measles treatment*

Age	On diagnosis	Next day
Infant <6 months	50,000 IU	50,000 IU
Infant 6–11 months	1,00,000 IU	1,00,000 IU
Children ≥12 months	2,00,000 IU	2,00,000 IU

* In complicated measles to minimize the risk of potentially blinding eye lesions, a third dose of vitamin A should be given 4 weeks later, the dosage being the same.

The *causative agent*, measles virus, is a member of the genus *Morbillivirus* of family *Paramitoviridae*.

Source of infection and modes of transmission are same as in case of chickenpox. It is communicable from four days before to five days after the appearance of rash. *Susceptibility* is more in children under seven years, the peak being noticed in three to four years old group. It is rare in infants below five months, probably because of maternal antibodies. Case fatality rate varies widely according to the nutritional status of the population as mentioned earlier. In USA the case fatality rate is close to zero. In Sri Lanka, India and Guatemala it is 0.7 percent, 2.2 percent and 4.6 percent respectively and it is as high as 6.6 percent in Kenya.⁶ These rates apply to the acute phase only. It is important to remember that measles is responsible for many more deaths than those occurring in the acute phase of measles. This is so because an attack of measles pushes the child into a downward spiral of diarrhea, malnutrition, lowered resistance, respiratory infections and further malnutrition. This is dramatically borne out in data from Gambia⁶ where it was found that while five percent children died of measles during the acute attack, an additional ten percent died within nine months following the attack of measles. It may be mentioned that the comparable death rate during this period in children who did not have measles was only one percent.

Incubation period: 8 to 16 days; average ten days.

Humans are only reservoirs. Only source of infection is a case of measles, since the virus has short survival time (<2 hours) outside the human body and carriers are not known to occur. Measles is a systemic infection and it is highly infectious, secondary attack rates among susceptible household contacts being more than 90 percent. Large family size, poor socioeconomic conditions, high population density and movement, poor housing, overcrowding are some of the favourable factors affecting measles transmission. In India the disease is seasonal being mostly noticed from January to April. Transmission of the disease is by person to person by droplet infection (airborne). Incubation period is 10 to 12 days (range 7–18). Incubation period of Vaccine induced infection is seven days, since it bypasses the respiratory tract – the portal route of entry. Recipients of measles vaccine are not contagious to others.

PREVENTION

- Measles vaccination has now been included in the Universal Immunization Program (UIP) of the Government of India.⁷ The vaccine is a live attenuated vaccine, a single dose providing up to 95 percent protection for five years if used properly.⁸ It is a freeze dried vaccine, the strain being Edmonston Zagreb strain. Diluent is pyrogen free

double distilled water. After reconstitution the vaccine should be given as early as possible, preferably within four hours. Reconstituted vaccine should be stored at +2°C to +8°C and disposed off after four hours. There would be loss of potency and complications such as toxic shock syndrome if used beyond four hours of reconstitution. 0.5 ml of reconstituted vaccine is given subcutaneously either in right upper arm or in anterolateral aspect of thigh. The vaccine is very sensitive to sunlight; hence it is supplied in amber colored vials.

This vaccine is given at completed nine months of age.

Rationale of giving at nine months of age: Measles vaccine interacts with maternally derived antibody in infants. This antibody persists in the infants till four to six months of age in same quantity from birth. Afterwards it starts declining gradually from six months till it completely disappears by 15 months. But epidemiologically it has been seen that incidence of measles is more common during nine to ten months of age. That is why it is a satisfactorily compromise between 6 and 15 months of age, i.e. nine months. Measles vaccine can be given earlier after six months of age during an epidemic, or exposure to a case of measles or if the child is malnourished. In that case the vaccine should be repeated again at completion of nine months for better seroconversion, keeping a minimum gap of four weeks. If the child comes late, then this vaccine can be given till five years of age.

Indications: Should be administered to infants and young children. It can also be given to teenagers and adults (including health workers) likely to be susceptible to measles.

Contraindications: Immunocompromised host.

In India the combined measles, mumps, rubella (MMR) live attenuated vaccine is manufactured using the following strains: Edmonston Zagreb for measles, L-Zagreb for mumps and the Plotkins RA 27/3 strain for rubella. The measles and the rubella components are produced using human diploid cells while the mumps component is produced from chick embryo. All the forms of MMR vaccine are available as 0.5 ml lyophilized mixed preparations of the various strains.⁹ Government of India has proposed Measles Rubella (MR) vaccine to be given with DPT booster at 16 to 24 months from 2009–10 in National Immunization Schedule.¹ Although IAP is in favour of two doses of MMR, one at the age of 12 to 15 months and second at school entry (4–6 years) or at any time four to eight weeks after the first dose. The second dose of MMR vaccine is to protect children failing to seroconvert against primarily mumps and less commonly against rubella.⁹

For adult immunization, two doses of MMR vaccine are recommended for health care workers;

in the setting of outbreaks; recent exposure to these infections; women who could become pregnant and college students.¹⁰

- b. When live attenuated vaccine is contraindicated, human immune globulin (IG) may be given in a single dose of 250 mg below one year, 500 mg between one and two years and 750 mg above three years of age (0.25 ml/kg body weight). Theoretical contraindications to measles vaccination include—pregnancy, immune deficiency disease, suppression of immune response (leukemia, lymphoma, generalized malignancy, corticosteroid therapy, irradiation, etc.). Vaccination should be deferred in febrile or serious illness till recovery and in active tuberculosis till starting antitubercular treatment. Immunoglobulins should be given within three days of exposure to the disease.¹¹ Measles, like smallpox, can be eradicated. In order to achieve this, sustained levels of at least 95 percent of immunisation must be maintained and active surveillance must be carried out.

Strategies for Measles Mortality Reduction

The plan of action mentioned in ‘Measles mortality reduction – India strategic plan 2005–2010 addresses the issues of reducing the measles mortality by 2/3rd by 2010, compared to 2000 estimates.⁵

Key Strategies

The strategies to achieve the goal of measles mortality reduction are:

- Achieving high routine measles vaccination coverage of infants at 9 to 12 months of age; administer measles vaccine to children above one year of age if not vaccinated earlier, at the earliest opportunity until the children are five years old.
- Establishing effective measles surveillance system that would provide information about number of cases, deaths by month, age and vaccination status of cases and deaths and to conduct outbreak investigation supported by laboratory confirmation. WHO – NPSP (National Polio Surveillance Project) and IDSP (Integrated Disease Surveillance Project) and different surveillance project of various states are involved in this surveillance.
- Improving case management of measles cases along with vitamin A supplementation. Vitamin A supplementation as part of measles treatment or episode reduces case fatality and the severity of measles.
- Providing a second opportunity for measles immunization to those who have not yet received vaccine or who did not develop immunity after vaccine administration. The measures being (a) One time only “catch-up” campaign and (b) “Follow-up” campaigns every three and four years or “Routine second dose”

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Mumps (ICD-B26.9)

CLINICAL FEATURES

Initial features are swelling of parotid gland obliterating the sulcus behind the ear lobule; fever 37.8 to 38.3°C for a day or so; and pain and tenderness in masseter region. One and two days later, other parotid or salivary glands may become involved. The degree of swelling, pain or discomfort may vary. This usually reaches its peak about two days after the onset and subsides between four to seven days. The parotid swelling extends from tip of the mastoid over the ramus of mandible forward to the cheek and downwards towards the neck, thus obliterating the space between tip of the mastoid and angle of the mandible. Inability to feel the tip of the mastoid aids in differentiating between parotitis and cervical adenitis. During its prodrome, **cowie's sign** first appears that is swelling and outpouching of the openings of stensen's duct on the buccal mucosa opposite the third upper molar. Similarly the orifices of sublingual and submaxillary glands become swollen and edematous. Leukocytosis occurs with an increase in lymphocytes. Virus may be found in saliva, blood and cerebrospinal fluid.

COMPLICATIONS

Orchitis occurs in adult males in 15 to 30 percent of cases, but is rare in childhood. It appears on the 7th or 8th day. Bilateral orchitis is rare. Very occasionally

it may lead to sterility.¹ Oophoritis and mastitis may occur in females; very rarely pancreatitis,² Insulin dependent diabetes mellitus may occur.³ In mumps the central nervous system is frequently infected and about 50 percent of asymptomatic patients exhibit pleocytosis in the cerebrospinal fluid (CSF).⁴ Aseptic meningitis occurs in up to ten percent of all mumps patients, more often in males. Meningitis⁵ and deafness⁶ are well-recognized complication of mumps. Mumps meningitis is a benign condition that appears within a few days of parotid swelling, although some meningitis patients do not have any parotid swelling.

Mild renal function abnormalities are common, but these usually resolve spontaneously.⁷ Transient electrocardiogram abnormalities, mainly changes in T waves and ST segments, have been reported in up to 15 percent of cases,⁸ while rare case reports of fatal nephritis or myocarditis have been published.⁹ Death due to mumps is exceedingly rare and is mostly caused by mumps encephalitis.

EPIDEMIOLOGY

Mumps is prevalent all over the world in endemic form. The incidence rises in winter and spring. It is caused by the virus—myxovirus parotiditis—which has a predilection for glandular and nervous tissues. The patient is infective seven days before the swelling and for a week after that, though to a lesser extent. Spread is by droplet infection and through fomites. Healthy contacts may also carry infection. Incubation period is two and three weeks, commonly 18 days. Susceptibility is more in young children and adults and the disease is rare in infants. Fatality is more in children up to five years of age. Immunity is long lived and develops after inapparent infection as well as clinical attack. Isolation is advisable till nine days after the onset of swelling, but for a lesser period if the swelling has subsided. Concurrent disinfection of articles soiled with nose and throat secretions is advisable.

PREVENTION

Live mumps vaccines are available as monovalent mumps vaccine, bivalent measles–mumps (MM) vaccine, and trivalent measles–mumps–rubella (MMR) vaccine. Sorbitol and hydrolysed gelatin are used as stabilizers in mumps vaccine, and neomycin is added as a preservative.¹⁰ Once reconstituted, live attenuated mumps vaccines must be used immediately or stored at 0 to 8°C, kept away from light, and discarded if not used within eight hours.¹¹ Vaccine may be administered 0.5 ml intramuscularly after one year of age. There are very few contraindications to mumps vaccination. Mumps vaccine should not be administered to individuals with immune deficiency or immunosuppression;

however, MMR vaccine can be given to asymptomatic and symptomatic individuals infected with human immunodeficiency virus (HIV) and who are not severely immunocompromised.¹¹ Mumps vaccine should not be administered to pregnant women because of the theoretical risk of fetal damage, and pregnancy should be avoided for three months after vaccination.¹²

Jeryl Lynn strain, Leningrad-3 strain, L-Zagreb strain, Urabe strain are the different strains of mumps virus that is being used in the vaccine. Rubini strain mumps vaccine does not appear to offer long-term protection against the disease. Countries that introduced mumps vaccine into the immunization programs exhibited a rapid decline in mumps morbidity. Countries implementing a one-dose schedule at high coverage levels reported reductions in mumps incidence of 88 percent. Countries implementing a two-dose schedule at high levels of coverage for both doses show reductions in mumps incidence of 97 percent, and several countries reached the elimination target of <1 mumps case per 100,000 population.¹⁰

INDIAN PERSPECTIVE

World Health Organization,¹³ Indian Academy of Pediatrics (IAP),¹⁴ National program for control of Blindness¹⁵ have recommended MMR vaccine. But National Technical Advisory Group on Immunization (NTAGI)¹⁶ considered mumps not as a public health problem in India and vaccination against it would not be cost-effective. It rather has recommended MR (Measles Rubella) vaccine (instead of MMR), in place 2nd dose of measles vaccine for all children at 16 to 24th months of age. Contrary to this, Government of Delhi included single dose of MMR (at 15–18 month) in its immunization schedule.¹⁷

MMR AND AUTISM

Concerns about a possible link between vaccination with MMR and autism were raised in the late 1990s, after the publication of a series of studies claiming an association between both natural and vaccine strains of the measles virus and inflammatory bowel diseases and autism.¹⁸ GACVS agreed and concluded that there is no evidence for a causal association between MMR vaccine and autism or autistic spectrum disorders.¹⁹

SAFETY OF MUMPS VACCINE

High rates of aseptic meningitis have been described for the Urabe, Leningrad–Zagreb, and Leningrad-3 vaccines relative to the Jeryl–Lynn vaccine. There is no known viral explanation for this difference based on virus genotype or phenotypic properties. All reported

cases of vaccine-derived mumps meningitis have been associated with recovery, without neurological sequelae. The committee has recommended establishment of an international reference laboratory for mumps vaccine virus isolates from vaccinated subjects.¹⁹

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German Measles (Rubella) (ICD-B06.9)

CLINICAL FEATURES

Rubella is a common cause of childhood rash and fever; its public health importance relates to the teratogenic effects of primary rubella infection in pregnant women. Mild eruptive fever with a measles like rash, appearing on first or second day of illness. The rash fades by the second day and disappears by the third. That is why it is also known as **three days measles**. Cervical glands are often enlarged. Lymphadenopathy helps to clinch the diagnosis when the rash is atypical.¹ The sequence of events is a prodrome, a rash, then lymphadenopathy followed, at times, by complications.

The causative agent is a togavirus that was successfully cultured in 1962. Prevalence is worldwide, with occurrence of periodic epidemics.

SUSCEPTIBILITY

More in children and young adults but all ages and both sexes are susceptible.

TRANSMISSION

The *spread of infection* is mainly by droplet infection and direct contact. A person is infective for two weeks—about one week before and one week after the appearance of skin rash, the maximum infectivity being at the time of appearance of rash.² The virus is present in throat, nose, pharynx, urine, stools and blood.³ The incubation period ranges from 12 to 23 days, with an average of 18 days. In pregnant women the virus infects the placenta and the developing fetus. Humans are the only known host. It may be mentioned that subclinical infections may be one to six times as common as clinical infection.⁴

CONGENITAL RUBELLA SYNDROME (CRS)

When a woman is infected with the rubella virus early in pregnancy (first trimester), she has a 90 percent chance of passing the virus on to her fetus that may result in multiple fetal defects and there is an approximately 50 percent increase in risk of spontaneous abortion. CRS manifestations in surviving infants may be transient (e.g. purpura); permanent structural manifestations (e.g. deafness, congenital heart disease, cataract); or late-emerging conditions (e.g. diabetes mellitus) **Table 16.4**. Sensorineural deafness may occur following maternal infection up to the 19th week of pregnancy, while cataract and heart disease only occur after infection prior to the ninth gestational week.⁵

Diagnosis of CRS

CRS may be diagnosed by its classic triad: cataract, heart disease, and deafness. However, many infants only

TABLE 16.4: Clinical manifestations of Congenital Rubella

General	Fetal loss (spontaneous abortion and stillbirths) Low birth weight Micrognathia
Ears and central nervous system	Sensorineural deafness: unilateral or bilateral Central auditory deafness Mental retardation, Speech defects, Autism
Cardiovascular system	Patent ductus arteriosus (PDA) Pulmonary arterial stenosis Ventricular septal defects
Eyes	Retinopathy Cataracts: pearly, dense, nuclear; 50 percent bilateral Microphthalmos
Transient neonatal manifestations	Thrombocytopenia, +/- purpura Hepatosplenomegaly Meningoencephalitis Bony radiolucencies Adenopathies
Late-emerging or developmental	Late-onset interstitial pneumonitis, 3-12 months Chronic diarrhea Insulin-dependent diabetes mellitus (type I) Thyroiditis

have one of these manifestations, or may present earlier with neonatal signs; laboratory confirmation of the diagnosis is therefore recommended. Rubella virus may be isolated for 6 to 12 months following birth, and occasionally longer, from nasopharyngeal swabs, urine specimens, or cerebrospinal fluid, or less commonly from tissues obtained by biopsy, autopsy, or surgical procedures. Rubella-specific IgM is readily detected in the first six months of life, and among a decreasing proportion of cases up to one year of age. Its detection usually indicates prenatal rather than postnatal infection. The persistence of rubella-specific IgG beyond six months (the age when maternally derived IgG would usually have waned) can be detected in 95 percent of infants with CRS. However, the presence of IgG in a child over six months of age may indicate either prenatal or postnatal infection; and identification of low-avidity IgG1 will indicate prenatal infection.⁵

Differential Diagnosis of Rubella

Rubella causes mild fever and maculopapular rash, often with occipital and postauricular lymphadenopathy. Arthralgia/arthritis is common in adults, particularly women. The differential diagnosis includes measles, dengue, parvovirus B-19, human herpesvirus-6, coxsackievirus, echovirus, adenovirus, and *Streptococcus* group A (beta hemolytic). Because of the difficulty in clinical diagnosis, studies that use serological confirmation are the most reliable, either by detecting rubellasppecific IgM, which is usually positive for up to six weeks after rash onset, or by demonstrating a fourfold rise in rubella-specific IgG antibody titre between acute and convalescent specimens.

PREVENTION

A live attenuated vaccine is available which confers solid long-term immunity in 95 percent cases.⁶ The main purpose of rubella vaccination is to prevent congenital rubella syndrome. There are a number of rubella vaccines available, either as single antigen vaccines or combined with either measles vaccine (MR), mumps vaccine or measles and mumps vaccine (MMR). Most currently licensed vaccines are based on the live, attenuated RA 27/3 strain of rubella virus, propagated in human diploid cells. The RA 27/3 vaccine is highly stable at -70°C . When stored at 4°C , its potency is maintained for at least five years. The vaccine should be stored at $2^{\circ}\text{C} - 8^{\circ}\text{C}$ and protected from light. The vaccine is administered by subcutaneous route.⁷ Government of India in its immunization schedule has selected MR (Measles Rubella) vaccine to be given with DPT booster at 16 to 24 months of age from 2009–10. The dose being 0.5 ml, subcutaneously at right upper arm.⁸

WHO recommends its use in all countries where control or elimination of CRS is considered a public health priority. The vaccines are highly protective and without significant adverse effects. Caring for CRS cases is costly in all countries. All cost-benefit studies of rubella vaccination, in developing and developed countries, have demonstrated that the benefits far outweigh the costs.

Ministers of health throughout the Americas are considering a plan to eliminate rubella and congenital rubella syndrome (CRS) from their countries by the year 2010, and the Pan American Health Organization is developing a regional plan of action to mobilize resources in support of the elimination of rubella/CRS by the year 2010. Rubella vaccination is economically justified, particularly when combined with measles vaccine. Large-scale rubella vaccination during the last decade has drastically reduced or practically eliminated rubella and CRS in many countries.⁹

In USA, routine immunisation of all children above one year of age is recommended. The approach adopted in the European countries, including UK, is vaccination of all girls aged 11 to 14 years.¹⁰ The vaccine is also available in combination with measles and mumps vaccine (MMR). Rubella vaccination is recommended for susceptible women in the immediate postpartum period and to teachers, nurses, doctors, older children, adolescents, students, childcare personnel, health care workers, military personnel and adult men in contact with women of childbearing age.¹¹

The vaccine should not be administered to pregnant women susceptible to rubella. The reason is that theoretically, even the vaccine, which is a live one, may be teratogenic. That is why adult females given rubella vaccine are cautioned to avoid pregnancy for three months.

If a woman in early pregnancy is found to have contacted rubella, medical termination of pregnancy is indicated. The occurrence of such infection may or may not be clinically evident. Confirmation can be obtained through serological tests and through isolation of the virus.⁷

- *Serological tests*
 - Presence of rubella specific IgM indicative of recent infection.
 - Four-fold rise in antibody titer over two serum samples collected 7 to 14 days apart, the first sample being taken as soon as possible (within ten days of onset of suspected illness).
- *Isolation of virus*

This can be done from the pharynx during a period from one week before the onset of the rash till one and two weeks after its appearance. Virus may also be isolated from urine, faeces and blood, but the time over which this is possible is shorter and less certain.

Antenatal infection of the fetus can be confirmed in the newborn by the presence of specific IgM antibodies in the serum.

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Nonspecific Bacterial Infections

Pneumonias (ICD-J18.9)

Pneumonias are described clinically as lobar pneumonia, bronchopneumonia and interstitial pneumonia. They may be bacterial or viral in etiology. Among bacterial pneumonias include those caused by *S. aureus*, *Staphylococcus pyogenes*, *Klebsiella* and *H. influenzae*. The typical pneumonia is caused by *Mycoplasma pneumoniae*

which was earlier referred to as PPLO (pleuropneumonia-like organisms). A brief description of pneumococcal pneumonia follows.

The pneumococcal pneumonia is an acute febrile infection with cough, dyspnea and, often, pleural pain. Pneumonia is usually lobar or segmental but a bronchopneumonia involvement is common in childhood and old age. The causative agent is *Streptococcus pneumoniae* which has more than 75 antigenic subtypes depending upon the type of capsular antigen. Incidence is highest in winter months. Pneumococci are commonly found in the upper respiratory tract of healthy persons throughout the world. Decreased resistance due to inclement weather, old age, alcoholism or debilitating disease favors the development of clinical disease. The infection spreads by droplets and by direct oral contact, but illness among casual contacts and attendants is infrequent.

The incubation period is one to three days. The patient is infective as long as oral and nasal discharge contains virulent pneumococci in significant numbers. Immunity lasts for several years after an attack, but is specific for the particular capsular serotype.

2nd November is being celebrated as World Pneumonia Day. Fever, cough and fast breathing in a child is a sign of pneumonia. Danger signs are inability to feed, lethargy, breathing trouble (head nodding), grunting in a child with fever and cough. Preventive measures being using warm clothes to cover the children during winter, keeping newborn babies especially wrapped with warm clothes during all seasons, hand washing and protecting children from smoke (tobacco, stove, etc.).

VACCINES

The pneumococcal polysaccharide vaccine (PPV), contains 25 µg each of purified capsular polysaccharide from 23 serotypes of *Streptococcus pneumoniae*. A single standard dose (0.5 ml) is administered by the intramuscular or subcutaneous route. Pneumococcal vaccination is recommended in patients undergoing splenectomy (preferably at least two weeks prior to splenectomy).¹

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Streptococcal Sore Throat (ICD-J02.0)

It is an acute inflammation of throat due, most commonly, to *Streptococcus hemolyticus*, group A (beta hemolytic) which also causes scarlet fever, impetigo,

puerperal sepsis, erysipelas and acute bacterial endocarditis. It is a very common ailment, more so in children. Infection may be exogenous or endogenous. Droplets, air, dust and fomites, all play a part in its spread. Its important complications are rheumatic fever and acute glomerulonephritis, hence it should be treated early. It responds well to sulpha drugs and penicillin.

Specific Bacterial Infections

Diphtheria (ICD-A36)

CLINICAL ASPECTS

Symptoms of diphtheria are largely caused by exotoxins that are absorbed into the blood from the site of lesion while the bacteria remain localized. There are four clinical varieties:

1. **Faucial:** It is characterized by fever ranging from 37.8 to 38.3°C, rapid pulse, enlarged cervical glands and spots of exudate or false membrane on the pillars of fauces, tonsils or pharynx. There may be bleeding if the membrane is detached. There is little or no pain in the throat. High fever 39.4 to 40°C is uncommon in diphtheria and is more suggestive of streptococcal infection. Fatality varies from 2 to 14 percent.
2. **Laryngeal:** It may be primary or secondary to faucial diphtheria and is characterized by hoarseness, loss of voice, croupy cough, obstruction to breathing and regression of chest wall, respiratory failure and death. Infection may spread to trachea. It is the most fatal form.
3. **Anterior nasal:** It is characterized by blood stained nasal discharge and ulcers on the nose, upper lip and cheek. It is a less toxic form of diphtheria.
4. **Other forms:** These are conjunctival and cutaneous diphtheria in which the membrane forms on ulcers or wounds. Membranous vulvovaginitis may occur in children through common towels used in the nursery. In severe cases, so called pseudomembrane is gradually formed in the throat, recognizable by their typical asymmetric, grayish-white appearance and strong attachment to the underlying tissue. Such pseudomembranes may extend into the nasal cavity and the larynx causing obstruction of the airways. Laryngeal diphtheria, which sometimes occurs even without pharyngeal involvement, is a medical emergency that often requires tracheostomy.^{1,2}

STANDARD CASE DEFINITION³

Suspect (History)

- Sore throat, mild fever, grayish-white membrane in throat.
- Exposure to a suspect case of diphtheria in the previous one week or a diphtheria epidemic in the area.

Probable (History and Clinical Examination)

An illness characterized by laryngitis or pharyngitis or tonsillitis and an adherent membrane of the tonsils, pharynx and/or nose.

Confirmed (Laboratory Tests)

Probable case that is laboratory confirmed or linked epidemiologically to a laboratory confirmed case, i.e. isolation of the corynebacterium diphtheria from throat swab or four fold or greater rise in serum antibody titer (only if both serum samples are obtained before administration of diphtheria toxoid or antitoxin).

COMPLICATIONS

Myocarditis and neuropathy are the most common and most serious complications. Myocarditis can cause heart block, cardiac arrhythmias and heart failure, which develop at the end of 2nd or beginning of 3rd week. The neuropathy usually involves the paralysis of cranial nerves (3rd or 7th) first, producing slurred speech, diplopia and difficulty in swallowing.

The extent of toxin absorption depends largely on the extent of the mucosal lesions. The following WHO-defined clinical conditions are associated with increasing risk of toxin-induced systemic disease: (i) the catarrhal form (erythema of pharynx, no membranes), (ii) the follicular form (patches of exudates over pharynx and the tonsils), (iii) the spreading form (membranes covering the tonsils and posterior pharynx), and (iv) the combined form (more than one anatomical site involved, for example throat and skin).¹

DIAGNOSIS

During outbreaks, clinical diagnosis is based on typical pseudomembraneous pharyngitis. Although laboratory investigation of suspected cases is strongly recommended, treatment should not be delayed while waiting for the laboratory results. Bacterial culture is the mainstay of etiological diagnosis. Material for culture should be obtained preferably from the edges of the mucosal lesions and inoculated onto appropriate selective media (Neisser's staining to look for the characteristic polychromatic granules in bacteria having a match stick appearance). Suspected colonies may be tested for toxin production using an immunological precipitin reaction. Diphtheria toxin gene may be detected directly in clinical specimens using polymerase chain reaction techniques.

OCCURRENCE

Diphtheria has almost disappeared from the developed countries. However, 120 countries still continue to report cases to the WHO. About 25000 cases still occur in India

per year.⁴ It is high between August and November, with peak in September. The occurrence of diphtheria reflects inadequate coverage of the national childhood immunization program. Therefore, obstacles to optimal vaccine delivery must be identified and forceful measures taken to improve immunization coverage.

Causative Agent

Corynebacterium diphtheriae, the Klebs-Loeffler bacillus (discovered in 1884) is a slender, club-shaped, Gram-positive bacillus that exists in four biotypes (*gravis*, *mitis*, *belfanti* and *intermedius*). In addition to the bacterial exotoxin, cell-wall components such as the O- and K-antigens are important in the pathogenesis of the disease. The heat-stable O-antigen is common to all corynebacteria, whereas the variable, heat-labile K-antigen permits differentiation between individual strains. Also, while the K-antigen is important for mucosal attachment, invasiveness is facilitated by the cord factor, a toxic glycolipid. The most important virulence factor of *C. diphtheriae* is the exotoxin, a bacteriophage-mediated, highly conserved polypeptide encoded by the bacterial chromosome. Outside the host cell, the exotoxin is relatively inactive, but following cellular attachment and internalization by its nontoxic fragment B, a highly toxic fragment (A) is detached that kills through inhibition of cellular protein synthesis. Diphtheria exotoxin causes both local and systemic cell destruction.¹ *Mitis* type is more common in India. *C. diphtheriae* is a hardy organism and can stand cold and drying outside the body. It is sensitive to heat and sunlight.

Source of Infection

Patients, mild and missed cases; and carriers, both convalescent and healthy. The major source of infection are the carriers, who are 20 times as common as clinical cases.⁵

Communicability Period

The period of communicability is variable depending upon the continuance of virulent bacilli in the discharge from lesions. It is usually two weeks or less and seldom exceeds four weeks. The rare cases that become chronic carriers may be infective for six months or more.⁶ The carrier stage is promptly terminated by chemotherapy. Two swab cultures taken at least 24 hours apart should be negative in order to declare that a person is noninfective.

Modes of Transmission

- Direct droplet and direct airborne.
- Indirect airborne by inhalation of contaminated dust of dried particles of the membrane.
- Through milk, contaminated by carriers, dust, or infected udder or the cow. This is not an important

route in India because of the practice of boiling milk before consumption.

- Fomites such as pencils, toys, and towels. This mode plays only an insignificant role.
- Carriers, convalescent or healthy.
- Cross infection in the wards.
- Nonrespiratory infection of wounds or cuts in the skin or mucous membrane of conjunctiva.

Susceptibility

No age is exempt. Highest incidence is in children between 1 and 15 years with a peak in the four to seven years group, after which there is a sharp decline because of natural immunization by subclinical infection. Case fatality has been estimated to be ten percent in untreated cases and five percent in treated cases.⁵ The highest case fatality rate is in the age group two to five years.

The natural immunity passively acquired from the mother is retained upto six months of age. Thus there is very low incidence in infants below 6 months. The disease is rare in adults. Common cold, chronic rhinitis and tonsillitis increase proneness to infection. Susceptibility or immunity is tested by Schick test which determines the presence or absence of antibodies in the blood. When antibodies are present, they neutralise the antigen injected and hence the latter fails to produce a reaction.

Schick Test

It is done by giving 0.2 ml (1/50 MLD) of Schick test antigen or toxin intradermally in one forearm, and heated toxin in the other for control. As an alternative, 0.1 ml fluid diphtheria toxoid vaccine in 1:10 dilution may be injected intradermally.⁷ The arms are inspected at 24 to 48 hours. The test is interpreted as follows:

- No reaction on either arm—*Negative reaction*. The person tested has enough antitoxin (0.03 units per ml serum) to neutralize the antigen.
- Test arm develops a circumscribed red flush, 1 to 5 cm in diameter, at 24 to 48 hours while the control arm does not show any reaction—*Positive reaction*. The flush is most marked on the fourth day. It then fades, becomes brown and desquamates on 5th to 7th day. A person with positive reaction is susceptible to diphtheria and needs immunization.
- Both arms develop an equal flush, less circumscribed than in a positive case—*False positive reaction*. The flush fades quickly and disappears by fourth day. This occurs due to allergic reaction to the foreign protein in the toxin. The test is read as negative and indicates adequate immunity.
- Test arm shows true positive reaction and control arm shows false positive reaction—*Combined reaction*. Such a person is susceptible to diphtheria as well as allergic to the antigen. He should be vaccinated cautiously, using very small but multiple doses.⁷

This skin test is now replaced by serological markers of immunity that require specialized laboratories for analysis.¹

INCUBATION PERIOD

Two to six days; average three and four days. Varies with the dose of infection and susceptibility of the person.

Prevention and Control

- *Early detection and notification*: Active search for cases in contacts and schools is a must. Notification is compulsory in most places.
- *Isolation*: It should be done in the house or hospital to the extent possible. Young children should not come in contact with the case. The case should be isolated till two nasal and throat swab cultures, taken not less than 24 hours apart and not less than 24 hours after the cessation of antibiotic therapy, are negative. When culture is not possible, isolation should be continued for 14 days after appropriate antibiotic treatment.
- *Quarantine*: Contacts whose work involves exposure to children should be excluded from such work till bacteriological examination shows that they are not carriers. Often it is not practicable.
- *Diagnosis*: One should depend on clinical features and antidiphtheric serum (ADS) should be administered without waiting for laboratory report if the suspicion is strong.
- *Treatment*: Cases, contacts and carriers, all have to be treated promptly:

Cases: Treatment should be started as early as possible without waiting for laboratory confirmation as it affects the prognosis and mortality. The sheet anchor of treatment is the administration of antidiphtheric serum. The dosage varies from 20,000 to 100,000 units depending upon the severity of disease. A single intramuscular injection is usually sufficient but a part of the total dose may be given intravenously in urgent situations. Care should be taken to rule out sensitivity to the antitoxin, which is of equine origin, before the same is administered. For this purpose, the past history of serum sensitivity should be asked for and a conjunctival or intradermal skin test should be performed using a 1:10 saline dilution of the antitoxin. In case of sensitivity, desensitization has to be done. In addition to the antitoxin, an appropriate antibiotic must be given. This may be in the form of procaine penicillin 400,000 units intramuscularly every 12 hours for 10 to 12 days or erythromycin 30–40 mg/kg body weight orally for 10 to 12 days.

Contacts: If the contact of a diphtheria case has been previously immunized, he should be given a

booster dose of the toxoid. If the contact has not been immunized previously but has been intimately exposed to a case, he should be given the first dose of the toxoid along with an appropriate antibiotic, and should be put under daily surveillance. If daily surveillance is not possible, diphtheria antitoxin should be administered after testing for hypersensitivity.⁶ A dose of 1000 units of the antitoxin is usually sufficient. Simultaneous active immunization at the time of passive immunization or after two weeks should also be carried out.⁸

Carriers: Carriers should be treated with penicillin or erythromycin and isolated till free of infection. Some persons recommend that unimmunized carriers should be given 1000 to 2000 units of the antitoxin along with a course of active immunization while carriers who have been immunized in the past should be given just a booster dose of the diphtheria vaccine.⁸

- **Disinfection:** Clothes, fomites and sputum should be properly disinfected.
- **Immunization:** Active immunization is done by using diphtheria toxoid which is prepared by treating the diphtheria toxin with formalin. It is rarely used alone. The routine is to use polyvalent vaccines. The latter may be in the form of DPT (Diphtheria, Pertussis, Tetanus vaccine or triple antigen) or DT (Diphtheria, Tetanus toxoid).

Slightly varying schedules for DPT administration have been recommended in different countries. The schedule and guidelines used in the UIP programme in India are given below:

- Three doses of DPT (0.5 ml deep intramuscular should be given at anterolateral aspect of thigh starting at six weeks. Due to adjuvant content of the vaccine, a granuloma is formed deep in the muscle mass, from where slow release of the vaccine occurs to the immune system. If given subcutaneously, there is chance of abscess formation. Anterolateral aspect of thigh is preferred due to presence of muscle bulk and absence of any important nerve fiber. The interval between each dose should not be less than one month. The whole course of three doses should be completed as soon as possible but definitely by the age of one year.
- Even if a scheduled dose has been delayed (not given within the stipulated 4–8 weeks), it should be given thereafter, as soon as possible, without starting the entire three dose schedule afresh.
- One booster of DPT is given 12 months after the third dose. At age of five to six years, a single booster dose of DT (not DPT) should be given. From 2009–10, DT booster will be replaced by DPT booster at five to six years of age.³ If the child has not been immunised in the past, two doses should be given at four to eight week interval. DT is given at this age in place

of DPT because almost all children are already immune to pertussis by the age of five years as a result of clinical or subclinical infection.

- Minor cough, cold, mild fever and moderate malnutrition are not contraindications for DPT vaccination.
- DPT vaccination should be postponed in the following conditions, high fever (above 101°F), acute or severe illness, severe malnutrition, active tuberculosis and history of convulsions or other central nervous system disorders following DPT vaccination in the past.

DPT should be stored at 2 to 8°C. Potency of the vaccine lasts up to 18 months if properly stored. The vaccine should not be frozen. Frozen vaccine should never be used. It can be identified by presence of granular or flaky particles.⁴

Diphtheria toxoid is one of the safest and one of the oldest vaccines in current use. In most cases, diphtheria toxoid is administered in fixed combination with other vaccines. For childhood vaccination, DTwP (whole cell pertussis) or DTaP (acellular pertussis) is generally used, often in combination with other antigens administered at the same time, such as *Haemophilus influenzae* type B, poliomyelitis, and hepatitis B vaccines, in order to reduce the number of injections. This is a positive development as long as adverse events remain infrequent and the immunogenicity of the individual components is ensured.¹

Government of India has proposed DPT-Hepatitis B-Hemophilus influenza B (Pentavalent) vaccine in its immunization schedule from 2009–10 in place of DPT and Hepatitis B vaccine from six weeks onwards.³

THIOMERSAL IN DPT VACCINE

Thiomersal has been used for more than 60 years as an antimicrobial agent in vaccines and other pharmaceutical products to prevent unwanted growth of microorganisms. There is a specific need for preservatives in multidose presentations of inactivated vaccines such as DPT. Repeated puncture of the rubber stopper to withdraw additional amounts of vaccine at different intervals poses risks of contamination and consequent transmission to children. Live bacterial or viral vaccines (e.g. measles vaccines) do not contain preservatives because they would interfere with the active ingredients.

In the late 1990s, concerns were raised in the United States about the safety of thiomersal; which contains ethyl mercury and this could potentially exceed the most conservative recommended threshold for exposure to methyl mercury set by US government agencies with vaccination.⁹

But removal of thiomersal could potentially compromise the quality of childhood vaccines used in

global programs. The GACVS has reviewed the issue and found no scientific evidence of toxicity from thiomersal-containing vaccines. As a result, the WHO Strategic Advisory Group of Experts, 36 at its June 2002 meeting, strongly affirmed that vaccines containing thiomersal should continue to be available so that safe immunization practices can be maintained.

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Whooping Cough (Pertussis) (ICD-A37.9)

It has come from a Latin word 'per' means intensive and 'tussis' means cough.

IDENTIFICATION

The disease involves trachea, bronchi and bronchioles. It occurs in two stages:

- **Catarrhal stage:** It lasts for five to ten days. The child has mild fever and catarrh with irritating cough which is worse at night.
- **Paroxysmal stage:** This is characterized by bouts or paroxysms of cough. During each bout, the child coughs five to ten times in rapid succession followed by holding of breath, stimulation of respiratory center and forced inspiration associated with a whooping sound. This restores color and strength to the child exhausted by the bout of cough. The child may experience five to ten paroxysms per day. The child may pass urine or stools during an attack of cough and may bite his tongue. Whooping cough may be complicated by occurrence of hernia, rectal prolapse and superadded pulmonary infection. The paroxysmal stage may last for up to six weeks.
- **Convalescent stage:** It lasts for 1–2 weeks.

STANDARD CASE DEFINITION¹

Suspect (History)

- Cough persisting for two weeks or more
- Fits of coughing which may be followed by vomiting.
- Typical whoop in older infants and children
- Exposure to a suspect case in the previous two weeks or an epidemic of whooping cough in the area

Probable (History and Clinical Examination)

A case diagnosed as Pertussis by a physician or a person with cough lasting at least two weeks with at least one of the following symptoms:

- Paroxysms (i.e. fits) of coughing
- Inspiratory whooping
- Post-tussive vomiting (i.e. vomiting immediately after coughing) without other apparent cause

Confirmed (Laboratory Tests)

Isolation of *Bordetella pertussis* or detection of genomic sequences by means of the polymerase chain reaction (PCR) or Positive paired serology.

DIAGNOSIS

It depends upon the recovery of the causative organism from nasopharyngeal swab obtained during the catarrhal and early paroxysmal stages. A quick method of establishing the diagnosis is the use of the direct fluorescent antibody technique for staining the nasopharyngeal secretions, provided this facility is available. The examination of blood shows a high total leucocyte count with lymphocytosis.

EPIDEMIOLOGY

Prevalence is worldwide. The disease is more common in temperate climate and in winters. It is caused by *Bordetella pertussis* which is viable at 0 to 10°C but cannot survive long in external environment. *B. parapertussis* may also be responsible for an occasional case. Incidence in India has declined from 698 per million population in 1978 to 124 per million in 1987.² Incidence and mortality are both higher in females. Most deaths occur below one year age. Case fatality ratio is 15 per 1000.³ There is no subclinical case and no chronic carrier. Secondary attack rate is about 90%.

SOURCE OF INFECTION

Infected humans, whether typical, mild or missed cases.

Spread

Mainly by droplets but also, to a small extent, through fomites. The disease is most communicable during the

later part of incubation period and in early catarrhal stage before the stage of paroxysmal cough develops. Communicability gradually declines thereafter. For ordinary nonfamilial contacts, the patient becomes practically noninfective in about three weeks despite persistent spasmodic cough. The guidelines recommended by the American Public Health Association for control of whooping cough are as follows. In case the patient has not received antibiotics, the period of communicability is counted from seven days after his exposure to three weeks after the onset of typical paroxysms. In case of those receiving erythromycin, the period of infectiousness extends from a week after exposure to a week after the onset of paroxysms.⁴

Susceptibility is generally more in children under five. There is no evidence of temporary passive inherited immunity in infants for the first six months of life. One attack confers prolonged immunity but the disease is known to occur in adults after exposure.

Incubation Period

Seven to fourteen days but not more than 21 days.

Methods of Control

Notification, isolation, etc. are similar as in other respiratory infections. Immunization for whooping cough is usually done in the form of DPT, the schedule for which has been described earlier under diphtheria.

Both whole cell and acellular pertussis vaccines are widely used. Some countries use the whole cell vaccine for the primary vaccination schedule and acellular vaccine for booster doses in older age groups, while other countries, like Germany and Sweden, use acellular pertussis vaccines for the primary schedule as well as for boosting. Many countries including Finland, Hungary, India, Netherlands, Poland and Romania produce whole cell vaccines that meet WHO standards.⁵

Potency of whole cell pertussis vaccine varies between and within batches. The active mouse protection test (AMPT) is used for assessing potency of whole cell vaccines against a challenge strain but is not suitable for assessing protection against naturally occurring strains. An improved aerosol challenge system can be used for assessing protection pertussis vaccine protect against any *B. pertussis* isolate. However, there is no agreed official test of potency for acellular vaccines and the WHO pertussis working group is studying different approaches.⁵

Contacts: Passive immunization of a contact to ward off the disease is not possible since immune serum globulin (IG), special pertussis hyperimmune globulin and convalescent serum are all without proven value. Also, the degree of immunity offered by active immunization is not absolute in case of pertussis. Hence the practical advice is as follows.⁴ If the contact is an infant, he should be separated from the patient and given

prophylactic erythromycin for ten days. If the infant can't be separated, erythromycin should be given for the whole period of communicability. If the contact is a child up to 3 to 4 years age and has been immunized, he should be given a booster as soon as possible after contact. If the child has not been immunized, he should be given prophylactic erythromycin. It is better to give erythromycin even to a child contact who has been immunized earlier.⁴

Cases: The treatment of patients suffering from whooping cough is mainly symptomatic. Antibiotics may shorten the period of communicability and may control secondary infection, but are often ineffective in controlling the symptomatology in an uncomplicated case. The antibiotic of choice is erythromycin. Children infected with Pertussis should receive plenty of fluids to prevent dehydration.

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Meningococcal Meningitis (ICD-A39.0)

CLINICAL FEATURES

All cases of meningococcal infection do not develop meningitis. A large number of them merely have symptoms of nasopharyngitis or septicemia without any meningeal involvement. Thus, there are the following three clinical variants:

1. *Nasopharyngitis alone:* Such cases are fairly common and account for spread and occurrence of the disease in sporadic form. They show no meningeal symptoms and form the bulk of the missed meningococcal infections. The infected persons effectively spread the disease through droplet transmission.
2. *Meningococccemia alone:* Such cases are not uncommon and are characterized by acute septicemia and, often, a petechial rash, sometimes with joint involvement. Ten to twenty percent of such patients develop the Waterhouse-Friderichsen syndrome associated with vasomotor collapse and death.
3. *Cerebrospinal meningitis:* This is the typical and most common form and is characterized by involvement of the meninges. Headache, temperature 37.3 to 38.9°C, slow pulse, vomiting, cervical rigidity,

Kernig's sign, Brudzinski's sign and, in young children, opisthotonus, are the common features. Kernig's sign is pain in the hamstrings upon extension of the knee with the hip at 90-degree flexion and Brudzinski's sign is flexion of the knee in response to flexion of the neck. Purpural or other types of rash may occur. Delirium, hydrocephalus and cranial nerve involvement, indicated by diplopia and paresis of ocular nerves, are common complications.

COMPLICATIONS

Vasculitis, Disseminated Intravascular Coagulation, hypotension, focal skin infarctions are common in severe infection. Adrenal hemorrhage, myocarditis, pneumonia, lung abscess, endophthalmitis, pericarditis, peritonitis, arthritis, endocarditis and renal infarcts may also occur. Deafness is the most frequent neurologic sequel seen in children.

DIAGNOSIS

Diagnosis can be confirmed by:

- Demonstration of the typical organisms in a gram-stained smear of the spinal fluid or the fluid from the petechiae.
- Culture of the organisms from blood or CSF.
- Demonstration of group specific meningococcal polysaccharides in the spinal fluid by latex agglutination, counter immuno-electrophoresis or coagglutination techniques.¹

OCCURRENCE

The disease is prevalent all over the world. In India, it occurs more in March and April. Characteristic features of an epidemic are:

- It occurs in sporadic form, not more than one case in a family. The prevalence is higher in jails, schools and hostels, etc. because of mass contact.
- A large number of healthy carriers are found. The percentage of carriers may be as high as 50 percent in military recruits.¹ This testifies to the low virulence of the organism.
- Some cases get only nasopharyngitis; they spread the disease but themselves remain undetected.
- Susceptibility to clinical disease is very low as testified by the fact that there is a high ratio of carriers to cases. That is why even nurses, doctors and contacts do not get meningitis.²

Causative Agent

Neisseria meningitidis is a gram-negative *Diplococcus* appears as kidney-shaped pairs with adjacent sides flattened in gram stains. In most persons, meningococci are commensal colonizers of the nasopharynx. Humans are the only natural reservoir. Mueller-Hinton media is used to culture in laboratories.

The meningococcal cell wall has lipid A-containing lipo-oligosaccharides (LOS, i.e. endotoxin) covered by a polysaccharide capsule. Antigenic variation of the capsule has 13 serogroups. The vast majority of meningococcal disease worldwide is caused by serogroups A, B, C, W135 and Y. LOS and several protein families (porin, opacity-associated protein [Opa]) found in the outer membrane complex are used to serotype strains within these serogroups.

Source of Infection

Carriers, patients and mild cases of nasopharyngitis. The patient is infective as long as the meningococci are present in oronasal discharges. If the organisms are sensitive to sulphonamides, they disappear within 24 hours after instituting treatment. Penicillin does not eradicate them fully from the oropharynx.¹ Infection is transmitted by droplets.

Susceptibility

It is low. Children are more prone than adults. Mortality rate in meningitis should be less than 10 percent if diagnosis is early and modern therapeutic and support measures are used.¹

Incubation Period

Two to ten days; average three to four days.

Prevention and Control

Isolation: This is needed up to 24 hours after the start of appropriate chemotherapy.¹

Protection of contacts: Sulphadiazine for five days or rifampicin for two days (adult dose: 600 mg bd) given as a chemoprophylactic measure.

TREATMENT

In view of the high prevalence of sulphonamide resistant strains, the antibiotic of choice at present for treatment of meningitis is penicillin G2. Intramuscular penicillin should not be used in patients who are in shock or on the verge of shock. The dose for adults is 100,000 units every two hours intramuscularly or 3,000,000-5,000,000 units intravenously every six hours. Ampicillin may be used as an alternative to penicillin. In case of sensitivity, chloramphenicol can be used with due precaution towards its toxic effects. It may be mentioned that the epidemiological pattern of disease is not influenced by treatment.³

Vaccine

The meningococcal polysaccharide vaccine consists of group-specific purified capsular polysaccharides from

serogroup A, serogroup C, serotype Y and serogroup W135 *Neisseria meningitidis*, depending on the vaccine. The vaccine is provided as a lyophilized powder for reconstitution with solution (diluent) for injection. The vaccine is given in subcutaneous route. Reconstituted vaccine should be maintained between +2°C and +8°C, protected from sunlight and it should be used within six hours of reconstitution. Vaccination consists of a single injection administered from the age of two years onwards. The duration of post-vaccine immunity is currently estimated to be three years in schoolchildren and adults, and slightly shorter in children less than four years of age.⁴

Meningococcal polysaccharide vaccine protects against meningococcal disease, mainly meningitis and meningococemia. The vaccine gives no protection against meningococcal meningitis caused by meningococci belonging to serogroups not included in the vaccine, e.g. other than A, C, Y and W135 for the quadrivalent vaccine. It does not protect against other forms of purulent meningitis caused by other Groups of *Meningococcus* or by *Haemophilus influenzae*, *Streptococcus pneumoniae*, etc.

The vaccine is indicated for the active immunization of adults and children of two years of age or more. The vaccine is recommended for use in controlling outbreaks of meningococcal disease targeting population at risk. It is also particularly recommended for groups known to be at particularly high risk of disease, e.g. Hajj/Umra travelers, subjects living in or visiting epidemic and highly endemic areas, subjects living in closed communities (such as those in armed forces units, training camps, or boarding schools), persons with immunological predisposition to meningococcal disease (such as asplenia and inherited immunological immunodeficiencies), and subjects found to be close contacts of patients with disease caused by meningococci.

Side Effects

These vaccines are very safe, and significant systemic reactions have been extremely rare. The most common adverse reactions are erythema and slight pain for one to two days at the site of injection. Fever exceeding 38.5°C occurs in one to four percent of the vaccinees.

Contraindications

The vaccine must not be administered to subjects with known hypersensitivity to any component of the product or to subjects having shown hypersensitivity after previous administration of the vaccine. It should not be used in subjects with acute infectious diseases and/or ongoing progressive (acute or chronic) illnesses.

Over 5.4 million doses of tetravalent conjugated meningococcal vaccine (Menactra) were distributed in

the United States since its introduction in 2005 through September 2006. During this time 17 cases of Guillain-Barré Syndrome (GBS) were reported among vaccinated persons. Analysis of these data suggests that there may be a small increased risk of GBS associated with vaccination.⁵

The Global Advisory Committee on Vaccine Safety (GACVS), an expert clinical and scientific advisory body (GACVS) has scrutinized data relating to the safety of outer membrane-vesicle based meningococcal B vaccines based on their usage in Cuba, France, New Zealand and Norway. They did not find any increased significant risk of myalgic encephalomyelitis (ME), also called chronic fatigue syndrome, in respect to serious AEFI.⁶

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Tuberculosis (ICD-A16.9)

Tuberculosis is probably the most important infectious disease in the world. It has been reported as one of the most important public health problems by all the regions of WHO.¹ Due to steady increase in cases, WHO declared in 1993 a state of global emergency against tuberculosis. It has been estimated that three million people die from tuberculosis in the world each year.² In the South East Asia region of WHO, tuberculosis occupies the fourth place among causes of death.¹ According to National Tuberculosis Institute, Bangalore, tuberculosis is responsible for 53 deaths per lakh population per year in India.³ This roughly corresponds to a mortality rate of 70 per 100,000 population. It is interesting to note that the corresponding rate in USA was 200 per 100,000 in 1906 but only 1.5 per 100,000 in 1976. The deaths due to pulmonary tuberculosis occur largely in the older age groups. The gravity of the problem of tuberculosis is related to the following factors:

- It has a high degree of prevalence. It is estimated that 1.5 percent of the Indian population above five years of age is suffering from radiologically active pulmonary tuberculosis and that a fourth of these,

i.e. about 0.4 percent of population, are sputum positive or infectious.²

- It is a chronic disease of long duration.
- It affects the cream of population, i.e. adults in age group 21 to 40 (males more than females) who, instead of providing support to others, become a liability themselves.
- Treatment is costly and prolonged.
- The social stigma and fear of contracting the disease are next only to leprosy.

OCCURRENCE

Studies in South India indicate the course of sputum positive tuberculous infection in the community to be as follows:⁴

- 22.1 percent cases become bacteriologically negative on their own without treatment in course of time (self cure).
- 61.9 percent cases continue to be bacteriologically positive and thus remain a source of infection.
- 16 percent cases die within an year.

It is clear from the above that 38 percent bacteriologically positive cases disappear from the community every year (through self cure or death). But almost an number of new cases are added every year through fresh infection, the total infective pool thus remaining rather constant over short periods of time. However, there are some indications that over a long period of time, this balance may be slowly altered so that the prevalence may ultimately decline as in the industrially developed countries.⁴ It may be clarified here that in the present context, as well as elsewhere in this discussion, a case of tuberculosis means a case of pulmonary tuberculosis unless indicated otherwise.

It is important to bear in mind that prevalence of tuberculosis and prevalence of tuberculosis infection are two very different things. *Prevalence of tuberculosis* refers to persons clinically suffering from tuberculosis. *Prevalence of tuberculosis infection* refers to persons who have evidence of having been infected by *M. tuberculosis* as evidenced by a positive tuberculin test. Only 5 to 15 percent of those newly infected with tuberculosis (i.e. those whose tuberculin reaction has converted from negative to positive) develop serious disease within five years if left untreated.⁵ The risk of direct progression varies with age. It is highest when infection occurs in preschool years, the next highest risk being found in infections beginning in adolescents and young adults. Out of those who remain well for five years following initial infection, three to five percent may develop clinical disease some time later in life as a result of recrudescence of infection. Thus, it is estimated that the overall morbidity rate in tuberculosis is 8 to 20 percent of the infection rate.⁵

The above estimates are only approximate and, as indicated earlier, only apply to pulmonary tuberculosis, which forms 91 percent of total tuberculosis. Nearly six percent of the nonpulmonary tuberculosis is accounted for by tuberculous meningitis and general miliary tuberculosis in infants and young children. Other nonpulmonary forms are tuberculosis of intestine, genitourinary system, bones and joints, skin, lymph nodes, etc.

The most relevant and practical epidemiological index of tuberculosis is the Annual Infection Rate.¹ This reflects the risk of being infected (or reinfected) in a given community during a year. Among the developed and economically privileged countries, this rate is 0.03 percent or even less. In the developing countries, on the other hand, it is 20 to 50 times higher.¹ Figures reported from Latin America, Africa and some parts of Asia are 0.2 percent, 0.25 percent and more than 0.3 percent.⁶ It is 1.6 percent in India.² The annual infection rate is also known as the tuberculin conversion index.

The tuberculization of population in India is widespread; on an average about one-third people are Mantoux positive at all times because of high quantum of infection in the environment. The chances of having had exposure to infection increase with age. This is clearly seen in **Table 16.5**. No country in the world had succeeded in reaching a point of control where the rate of natural reactors in children up to 14 years falls below one percent. In India it is 40 percent.⁷

The figures given in **Table 16.5** correspond to recent times. Tuberculosis infection was much more common earlier. In 1951, the proportion of tuberculin reactors in persons aged 5 and 25 years in different states of India was 10 to 32 and 67 to 88 percent respectively.⁵

While **Table 16.5** gives the prevalence of tuberculin reactors, the data given below **Table 16.6** show the prevalence of tubercular disease.

CAUSATIVE AGENT

The causative agent is *Mycobacterium tuberculosis*. A bovine strain of this organism also sometimes causes infection in man, but is rare in India because of the

TABLE 16.5: Tuberculin positivity in population (Data from National Tuberculosis Institute's longitudinal study, Fourth Round).

Age (years)	% of reactors
0-4	1.0
5-9	6.4
10-14	15.4
15-24	31.9
25-34	47.3
35-44	54.8
45-54	60.7
55 +	62.1
All ages	
Males	35.0
Females	25.0
Both sexes	30.4

TABLE 16.6: Prevalence of tuberculosis in India⁵

Age (Years)	Prevalence per 100,000		
	Males	Females	Both sexes
5–14	80	50	65
15–34	400	200	300
35–54	925	300	600
55 +	1900	325	1100
All age groups combined	552	200	378

habit of boiling milk. Some atypical mycobacteria also cause sporadic infection in man. Such infection simulates tubercular infection and is responsible for nonspecific sensitivity to tuberculin as also for a certain degree of immunity to tuberculosis. The atypical mycobacteria are often resistant to the usual anti-tubercular drugs.

Tubercle bacilli cannot stand direct sunlight. They are killed by heat and disinfectants such as phenol and cresol but are more resistant than other bacteria to chemical disinfectants like acids and alkalis. They stand drying and remain viable in dried sputum for long periods.

SOURCE OF INFECTION

The reservoir is almost always a case of pulmonary tuberculosis with positive sputum. Milk and meat of bovine cattle may rarely be a source of infection, especially for nonpulmonary tuberculosis.

MODES OF TRANSMISSION

Inhalation: Bacilli from lungs and bronchi of open cases come out in the form of droplets on coughing, sneezing, laughing or talking. Small droplets are inhaled directly (Direct droplet transmission). Droplet nuclei remain suspended until inhaled, (Directly airborne) or, drop down if they are heavy and get mixed with dust. This dust, when stirred by sweeping or blown by wind, is inhaled by other persons (Indirect airborne).

Ingestion: As mentioned earlier, unboiled milk or uncooked meat of diseased cattle may, on ingestion, rarely initiate intestinal tuberculosis or mesenteric adenitis.

Surface implantation: Very rarely, primary lesion may start in the skin or mucous membrane, e.g. Lupus vulgaris and laryngitis.

SUSCEPTIBILITY AND RESISTANCE

Entry of tubercle bacilli into the body is not necessarily followed by tuberculosis. The result depends on certain host and environment factors that are poorly understood.

HOST FACTORS

Heredity: It plays little role, if any, as a determinant of tubercular infection.

Race: Caucasian (which includes most Indians) and Mongoloid races have a distinct natural resistance to tuberculosis compared to Africans, American Indians and Eskimos. The former have an ability to develop an immune response to infection, thus enabling spontaneous recovery from initial infection (though recrudescence may, of course, sometimes occur late in life). This ability is less in the latter group in whom the infection tends to be more rapidly progressive.⁵

Age: Children under two are most susceptible to new infection. The resistance starts increasing at two years and is high in school age, i.e. 5 to 12 years. Then it decreases again and is low in adolescents. It starts rising again and goes on increasing throughout life.

Sex: Prevalence of tubercular disease is higher in males than in females at all ages and the difference becomes more marked as age increases. While it is insignificant in early childhood, the male female difference becomes six fold in persons above 55 years of age. This is clearly brought out in **Table 16.6**. However, the male female difference is not marked as regards the prevalence of tubercular infection.

Malnutrition: Extreme malnutrition or general debility would certainly make a person more prone to tuberculosis or any other infective disease.

Other diseases: Silicosis, diabetes, hypothyroidism and hypoadrenalism predispose to tuberculosis.

Specific immunity: It is acquired through primary subclinical infection or BCG vaccination and provides good protection against the disease. The immunity is mainly cell mediated in nature, operating largely through *T lymphocytes*. The role of immunoglobulins is less clear, though it is known that serum IgA is often increased in patients with active tuberculosis and drops as the infection is controlled by therapy. Immunity should not be confused with tuberculin hypersensitivity, which is the reaction to tuberculin, a protein derivative of the broth in which tuberculin bacilli have been grown. Presence of tuberculin hypersensitivity indicates the presence of living tubercle bacilli. The larger the skin reaction, the higher the possibility that the infection is clinically significant.

Smoking: There is statistically significant evidence that both active and passive smoking predispose to development of tuberculosis.^{8a}

Environment Factors

Housing: Chances of repeated and massive doses of infection are more when people live in dark, ill-ventilated, overcrowded houses. As a result, the risk of developing tuberculosis is increased.

Social factors: Transmission of tuberculosis is favoured by large family size, poverty, ignorance about the mode of spread and occupational environment (Staff in TB

hospitals, employees in dusty trades). Customs like early marriage, Pardah system, and habits like indiscriminate spitting and smoking a common pipe (Hukka) also increase the chance of occurrence of disease.

INCUBATION PERIOD

It is 4 to 12 weeks from infection to primary lesion, but from infection to disease it may be years. The chances of getting the disease are more during first 6 to 24 months of life.

PATHOGENESIS

The characteristic lesion is the tubercle, a nodular collection of epithelioid cells, giant cells and tubercle bacilli in the center, surrounded by lymphocytes and fibroblasts. Adjacent tubercles enlarge and coalesce to form a mass. There is central necrosis, caseation, tissue destruction and peripheral spread. Healing takes place by fibrosis and calcification. Destruction and healing frequently coexist.

Initial or primary lesion: Primary lesion is found usually in the lung but occasionally in tonsils or alimentary canal, especially the ileocecal region. There may be enlargement of regional lymph nodes such as the mediastinal, cervical or mesenteric, depending on the site of initial lesion. The lesion heals and calcifies completely in most people without producing any clinical picture. There may be a short period of fever or malaise often attributed to other causes. Allergy and immunity against tuberculosis are produced within six to eight weeks.

If healing is incomplete the disease process is activated and the disease may spread. It may lead to pneumonic and bronchopneumonic forms, involvement of pleura, pericardium and regional lymph nodes or discharge of bacilli into the blood stream. Hematogenous spread may cause tuberculous lesions in bones, joints or kidneys. Occasionally, it may lead to acute miliary tuberculosis or tuberculous meningitis.

Late or adult type lesion: Tuberculosis in the adolescent or adult age may be a flaring up of the old, incompletely healed or unhealed primary focus but, more often, it is due to reinfection and is called postprimary pulmonary tuberculosis or adult phthisis. The characteristic feature in adult pulmonary tuberculosis is a cavity. There is a strong tendency towards limitation of the disease by fibrosis.

CLINICAL IDENTIFICATION

It is made on the basis of general symptoms due to toxemia and local symptoms due to local effects.

- **Toxemic symptoms:** They are related to the activity of the lesion and not its size. Common ones are low

grade pyrexia, especially in the evening, general debility, loss of weight and increase in ESR.

- **Local symptoms:** They depend upon the site of the lesion as follows:
 - **Pleura:** Pleuritic pain and dyspnea due to pleural effusion.
 - **Lungs:** Persistent cough with or without expectoration and hemoptysis.
 - **Larynx:** Hoarseness of voice.
 - **Intestines:** Diarrhea, malabsorption, intestinal obstruction.
 - **Peritoneum:** Ascites.
 - **Kidney and bladder:** Frequency of micturition and painless hematuria.

Other organ related local symptoms and signs are seen when cervix, epididymis, meninges, lymph glands, suprarenal glands, bones and joints, skin, or eyes are involved.

Clinical diagnosis is confirmed by direct examination of sputum and discharges and by AFB culture and guinea pig inoculation. Roentgenography is often necessary but X-ray alone is not dependable as an indicator of etiology and/or activity.

Field diagnostic surveys are based on tuberculin test and sputum examination. Mass miniature radiography is no longer recommended by the WHO as a mass diagnostic tool. The drawbacks of MMR, which was quite in vogue some years ago, are its high cost and its relative nonspecificity, the radiological shadows not being a definitive proof of tuberculosis. Cases screened by MMR have still to be bacteriologically examined to confirm the diagnosis of tuberculosis. Thus this method has been found to have a low benefit cost ratio.^{8b}

A recent study from East Africa^{8c} attempted to identify the clinical, X-ray and laboratory features on the basis of which tubercular patients could be identified among 182 indoor patients having respiratory disease, all of whom had two AFB negative sputum smears. 41 were found to have tuberculosis. Stepwise regression analysis revealed four easily identified symptoms associated with tuberculosis. These were:

- Cough for more than 21 days
- Chest pain for more than 15 days
- Absence of expectoration
- Absence of breathlessness.

Any two of the above four diagnosed tuberculosis with 85 percent sensitivity and 67 percent specificity. Any three of four had diagnostic sensitivity and specificity of 49 and 86 percent respectively. There is a need to develop similar criteria for outdoor patients also.^{8c}

PREVENTION AND CONTROL

First of all, we shall discuss the prevention and control of tuberculosis as per the standard levels of prevention. Then, the national measures adopted in India will be described.

Health Promotion

Improvement in general health and resistance by raising the standard of living through socioeconomic development is of paramount importance. The great reduction in tuberculosis in the socioeconomically advanced countries of America, Australia and Europe and its low incidence in upper social strata of society all over the world are attributable to this factor. A fall in incidence of tuberculosis parallel to socioeconomic development was noticed even before any specific treatment for tuberculosis became available. Improved standards of living include provision of well lighted, ventilated and open houses, congenial working conditions, good nutrition, facilities for recreation, freedom from worry and healthy habits.

Specific Protection

Health has to be specifically protected against tubercular infection. The measures include immunization, chemoprophylaxis, isolation of cases, disinfection and health education.

Immunization (BCG vaccination): All persons should be given BCG vaccination. The earlier policy was to screen the population by tuberculin testing to find the noninfected cases and to give them BCG. In 1964, the WHO recommended direct BCG vaccination without any pretesting. This practice has since been followed in India and no adverse effects have been detected. The antigen used is BCG (Bacille Calmette Guerin), which is an attenuated strain of the tubercle bacillus. WHO has recommended that the laboratories should use "Danish 1331" strain for the production of vaccine. In India, the vaccine is manufactured at BCG Vaccine Laboratory, Guindy, Chennai, using this strain.⁸

BCG is a freeze-dried vaccine. It remains potent up to one year in refrigerator and for one to four weeks at room temperature. The reconstituted vaccine should be used within three hours.

Vaccination technique: 0.1 ml or an amount that produces a wheal about 8 mm in diameter is given by intradermal injection over the deltoid muscle, using a tuberculin syringe (Omega microstat syringe) and intradermal needle. The moist weight of the bacilli contained in 0.1 ml of the reconstituted vaccine is 0.075 mg. In newborns upto four weeks of age, only 0.05 ml of the vaccine is administered. The reason for this is that their skin being too thin, intradermal infection using the full dose is difficult without spill over to deeper tissues. The half dose (0.05 ml) is recommended in children at birth and 0.1 ml it is recommended from six weeks of age.

The skin is stretched between thumb and forefinger and sterile needle (25G or 26G) inserted bevel upwards for about 2 mm into superficial layers of the dermis

(almost parallel with the skin with an angle of 10 to 15 percent). Raised blanched bleb (7 mm bleb with 0.1 ml injection) showing tips of hair follicles is a sign of correct injection.

Local reaction: It is similar to primary smallpox vaccination reaction but progresses slowly. Nothing happens for two weeks. Redness and induration at the site are seen in the third week. A papule then develops, reaching the maximum size in the 4th week. The papule cracks, discharges pus and is gradually changed into a crust during the 5th or 6th week. The scab falls off during the 7th or 8th week leaving a small oozing ulcer which heals and leaves a scar or keloid about 5 mm in diameter. Indurations, tissue destruction and other reactions after direct BCG vaccination are more marked in positive reactors.⁹

Contraindications: BCG vaccine is contraindicated in hypogamma-globulinemia, congenital immunodeficiency, sarcoidosis, leukemia, generalized malignancy, HIV infection or any other disease in which natural immune response is altered, as also those on immunosuppressive therapy, corticosteroids, radiotherapy. In chronic eczema or other dermatological disease, the vaccine can be given in a healthy area of the skin.

Complications: Delayed healing, enlargement of regional lymph nodes, keloid formation and, very rarely, lupus and local abscess.

Children born to HIV seropositive mothers: The passage of maternal antibodies (IgG) through the placenta makes it impossible to interpret the serology of the child until the age of about nine to ten months (maternal antibody may persist up to 14 months of age). Therefore, it is necessary to wait until the child has been found negative either serologically or by detection of viral genome. If the child is infected, BCG vaccine is contraindicated irrespective of the child's condition or symptom, given the potential risk of development of 'BCG-itis' in the vaccinated child.

Nature of immunity: BCG vaccination continues to be surrounded by controversy.¹⁰ A recent review describes 19 controlled trials that report wide variation in efficacy of BCG vaccine.¹¹ The Tuberculosis Prevention Trial, Chennai (Madras) has even reported a zero percent effectiveness of BCG in prevention of tuberculosis.¹² Another review¹³ of 13 case-control studies reported efficacy of BCG ranging from 2 to 89 percent, the efficacy being more in preventing primary tuberculosis than pulmonary tuberculosis. A recent hospital based retrospective case control study from Nagpur found only very limited protective efficacy of BCG.¹⁴ In the face of the conflicting reports, the WHO recommends continuation of the ongoing BCG vaccination program.^{15,16}

BCG vaccination has been found, after 25 years worldwide trial, to be harmless and effective, especially in preventing general military tuberculosis and

tuberculous meningitis. It is the cheapest and easiest method for prevention and control of the disease. In developing countries like India, where there is a high risk of infection coupled with minimal resources, BCG vaccination is an important tuberculosis control measure. It is advisable to revaccinate children in school at 12 to 15 years. The international recommendation for developing countries is to give a dose of BCG to school children at age of entry to the school, i.e. around six years.^{8b} The reasons for school vaccination are as follows:^{8b}

- The immunological response of infants is poor and it has never been shown that the reduced dose of BCG given to babies affords lasting protection.
- The risk of tuberculous infection in many developing countries is still high (1.5–2.5 percent or more) and most infections occur after puberty. Vaccination at the age of 6 years may protect children up to about 20 years of age.
- Vaccination at school is feasible and, due to growing school attendance, will cover the vast majority of children in the near future.

Tuberculin test: The test consists of introducing tuberculin, a protein of the tubercle bacillus, into the skin and observing whether or not an allergic reaction develops. Formerly old tuberculin (OT) obtained from heat-killed culture was used but now the purified protein derivative (PPD) is used. OT and PPD are both standardized by WHO. The generally accepted and standard method of Mantoux test for the purpose of tuberculin surveys consists of injecting 0.1 ml PPD containing one tuberculin unit. The injection is given intradermally with the help of a tuberculin syringe on the anterior side of the left forearm, so as to raise a wheal about 8 mm in diameter. The result is read after 48 to 72 hours when redness and induration are seen. The former is disregarded. Induration is measured in millimeters. An induration 10 mm or above in longitudinal diameter is considered positive. Sometimes 14 mm is also used as a cut off point in tuberculin surveys. In clinical practice, tuberculin test is routinely performed using 5 TU (tuberculin units). The BCG teams in India use 1 TU dose (equal to 0.00002 mg of the International Standard PPD) for routine testing. Strong reactors, particularly those with induration more than 20 mm, have more chance of developing active tuberculosis. Also, weak reactors (less than 5 mm induration) have more risk of developing the disease.

The sensitivity of tuberculin test is relatively constant in different populations as long as their cellular immunity is not compromised. WHO studies on 3600 hospitalised tuberculosis patients in ten countries in 1950's revealed that the sensitivity of tuberculin test for identifying tuberculosis infection was 93 percent for an induration of 10 mm or more and 78 percent for 14 mm or more. In a study in the seventies in healthy US

naval recruits with history of exposure to tuberculosis, the two sensitivities were 94 and 75 percent respectively.^{8b} However, the specificity of the test varies depending upon sensitisation by environmental mycobacteria other than *M. tuberculosis*. BCG vaccination also induces cross reactivity to tuberculin PPD to a variable extent^{17a} (17a-Menzies R, Vissandjee B 1992. *Am Res Resp. Dis* 145:621-5,1992).

The tuberculin test has to be interpreted cautiously. It cannot distinguish between old and recent infection. Likewise, it cannot distinguish between infection by *M. tuberculosis* and other mycobacteria. In general, large tuberculin reactions are associated with higher risk of developing active tuberculosis. However, in an individual patient, the test cannot accurately predict the risk of future disease. There is no clear evidence of significant association between BCG vaccination and tuberculin sensitivity (17b—Johnson H *et al: Tubercle and Lung Disease* 76: 122-5, 1995). Four factors need to be taken into consideration while interpreting tuberculin sensitivity. These are infectivity of the case and age, BCG status and general health of the contact who is tuberculin tested. The British Thoracic Society considered the first three of these to be the key variables while the American Thoracic Society gives importance only to the first one. A recent study suggest that the first two, i.e. infectivity and age are the important factors.^{17b}

Chemoprophylaxis: It implies prevention of disease by giving drugs like isoniazid to two types of contacts:

- **Primary Chemoprophylaxis:** When the drug is given to a person, not infected so far (negative reactor), who has been exposed to an open case. This approach is totally irrational.
- **Secondary Chemoprophylaxis:** When INH is given to a person already infected (positive reactor) in order to prevent development of tuberculosis. This approach may be of value in high risk cases, such as preschool children in contact with an open case in the family. Chemoprophylaxis for tuberculosis is totally unrealistic and impractical in the Indian context. It is indicated only in conditions where a highly organized and efficient program for control and treatment of tuberculosis exists in a community resulting in a high rate of cure.¹⁷

Isolation: The availability of potent chemotherapeutic drugs has radically changed the earlier approach towards isolation and treatment of the patient. Isolation would be logically needed only for those cases of pulmonary tuberculosis who have cough and whose sputum smear is positive for tuberculous bacteria. A good therapeutic regimen renders such a case sputum negative within a few weeks. Even in such cases, strict isolation is neither necessary nor practical in real life. It suffices to ensure that the patient covers his mouth and nose during coughing and sneezing and that the

oronasal discharges or articles soiled by them are properly disposed of. Those attending upon open cases should preferably use face masks. Special care should be taken to prevent the exposure of young children to open cases and to vaccinate them with BCG, if not already vaccinated.

Disinfection: Cheap handkerchiefs, cotton tissue towels and paper boxes, etc. used to receive the sputum and nasal discharge of the patient should be burnt. Sputum cups should contain 50 percent carbolic lotion. Disposal of sputum should be done by burying it into soil or by burning. A safe, cheap and practical method is to receive the sputum in a small tin can (such as a cigarette tin) and to put boiling water in it. This would kill the bacilli within minutes. Cups and utensils should be disinfected by boiling. Beds and bedding should be exposed to sun. Floors should not be swept dry but rather wet mopped. Flies should not be allowed to sit on sputum or discharges of the patient.

Health education: Relatives, friends, and contacts should be advised to avoid exposure and to get BCG vaccine if necessary. The public in general should be told about the mode of spread of the disease and the necessary safety precautions.

EARLY DIAGNOSIS AND PROMPT TREATMENT

The disease remains hidden for a long time because of the stigma attached to it. Very often, the presumptive clinical symptoms and chest examination by the doctor are sufficient for diagnosis. Confirmation should be made by sputum examination and radiography. It is important to diagnose cases discharging tubercle bacilli so as to break the chain of transmission of disease. Effective chemotherapy is the only means of reducing the infectious pool in the community which is comprised by open cases of tuberculosis discharging tubercle bacilli in the sputum. A detailed account of chemotherapy for tuberculosis will, therefore, be presented.

Principles of Chemotherapy

- Drugs should be chosen to which the bacilli are likely to be susceptible. INH is the cornerstone of anti-tubercular treatment. When there is doubt that the infecting bacilli may be resistant to INH, as may be common in India, it is better to start an extra drug (i.e., a 3 drug regimen) till the results of sensitivity studies are available. ICMR's Drug Resistance Survey¹⁸ revealed that among patients presenting to TB clinic for the first time, 25 percent were resistant to INH, 23 percent were resistant to streptomycin, 16 percent were resistant to both and 32 percent were resistant to any one or both.
- Treatment must be started with at least two effective drugs to minimize the possibility of development of resistant strains.

- Bactericidal drugs are preferable to bacteriostatic drugs. Their advantage is obvious from the fact that when one bacteriostatic and one bactericidal drug are used, the treatment has to be continued for 18 to 24 months. On the other hand, when two bactericidal drugs are used together, treatment is needed for only nine months. Among bactericidal drugs the two most important ones are INH and rifampicin. These kill intracellular as well as extracellular bacteria. Of the other bactericidal drugs, streptomycin kills only extracellular bacteria and pyrazinamide kills intracellular forms. Ethionamide also is bactericidal. Other drugs (ethambutol, PAS, thiacetazone) are only bacteriostatic.
- When treatment appears to be failing (i.e. the patient does not become bacteriologically negative within 2–4 months), never add another single drug to improve the situation. In such a situation, an entirely new regimen should be instituted, which should contain at least two new drugs. Also, great care should be taken to ensure regular intake of drugs by the patient.
- Treatment must be continued long enough. As mentioned earlier, INH and rifampicin (both bactericidal) have to be continued for at least 9 months, while regimens without two bactericidal drugs have to be continued for 18 to 24 months.
- All medicines should be given before breakfast and in a single dose, if possible. This ensures a single combined peak concentration for maximum effect on the bacilli.
- Initial daily drug administration for about two months results in significant bacterial reduction. Twice weekly doses can then be given with good results. The pattern of drug administration is indicated by a prefix and a suffix to the name of the drug. The prefix indicates the number of months. The suffix indicates the frequency of administration. For example, 4 H₂ R₂ means isoniazid and rifampicin given twice a week for four months, while 6TH means thiacetazone and isoniazid given daily for six months.

Chemotherapy Regimens

It has been detailed under RNTCP program.

Drug Toxicity

It is particularly important to keep in mind the manifestations of INH and thiacetazone toxicity as described below:

- INH toxicity: Toxicity to INH is not common but should be always kept in mind. It is of three types:
 1. *Direct toxicity:* It consists of peripheral neuropathy and anemia due to competition of INH with pyridoxine. It can be easily managed by giving pyridoxine 20 to 50 mg daily.

2. *Allergic reactions*: These comprise of skin rash, arthralgia and fever and may necessitate withdrawal of the drug.
 3. *Hepatocellular toxicity*: This is the most serious with INH administration. Anorexia, nausea and vomiting, followed by jaundice, are the warning signs towards which both the doctor and the patient should be alert. Suspicion is confirmed by the finding of a three fold elevation in serum levels of anyone of the following: SGOT, alkaline phosphatase, bilirubin.
- Thiacetazone toxicity: Thiacetazone is not permitted for clinical use in USA. The adverse effects include hepatotoxicity and skin rashes. The latter may rarely manifest as exfoliative dermatitis.

DISABILITY LIMITATION AND REHABILITATION

When the disease is arrested, sputum is negative, X-ray shows no activity, and the patient feels normal, he should take full and active part in the economic and social life of the community. His job may have to be modified or changed by occupational therapy and vocational guidance, especially if he works in industries with risk of exposure to dust and fumes. He should be asked to report for rechecking at required intervals and should be kept under care through health visitors and social workers.

Revised National Tuberculosis Control Programme^{19,20}

In 1992, the Government of India, together with the World Health Organization (WHO) and Swedish International Development Agency (SIDA), reviewed the National TB Program (NTP). Based on the findings and recommendations of the review, the Government of India evolved a revised strategy and launched the Revised National TB Control Program (RNTCP) in the country.

The Revised National Tuberculosis Control Program (RNTCP), based on the DOTS strategy, began as a pilot in 1993 and was launched as a national program in 1997. Rapid RNTCP expansion began in late 1998. By the end of 2000, 30 percent of the country's population was covered, and in 2005, more than 1290,000 cases were placed on treatment—largest cohort of cases, more than any other country in the world. The entire country was covered under DOTS by 24th March 2006. The DOTS strategy is cost-effective and is today the international standard for TB control programs. To date, more than 180 countries are implementing the DOTS strategy.

Program Goals

- To reduce mortality and morbidity from tuberculosis.
- To interrupt chain of transmission until TB ceases to be a major public health problem.

Objectives

- To achieve and maintain a cure rate of at least 85 percent among newly detected infectious cases (new sputum smear positive) and
- To achieve and maintain detection of at least 70 percent of such cases in the population.

However, the target for case detection should only be attempted once the cure rate of 85 percent is achieved among new sputum smear-positive patients already detected.

Five Key Components of DOTS

1. Political and administrative commitment
2. Good quality diagnosis, primarily by sputum smear microscopy
3. Uninterrupted supply of good quality drugs
4. Directly observed treatment (DOT)
5. Systematic monitoring and accountability

Organization Structure

At the State level, the State Tuberculosis Officer (STO) is responsible for planning, training, supervising and monitoring the program. The district level (or municipal corporation level) performs similar functions and here primary health care services are provided. A major organizational change in RNTCP is the creation of a subdistrict level (Tuberculosis Unit). In Tuberculosis unit (TU), there is a designated Medical Officer-Tuberculosis Control (MO-TC), a Senior Treatment Supervisor (STS) and a Senior Tuberculosis Laboratory Supervisor (STLS). TUs are generally based in a Community Health Center (CHC), Taluk Hospital (TH) or Block Primary Health Center (BPHC). The TU covers a population of approximately 5,00,000 (250,000 in tribal, desert, remote and hilly regions). The TU has one Microscopy Center for every 1,00,000 population (50,000 in tribal, desert, remote and hilly regions) known as the Designated Microscopy Center (DMC) (**Fig. 16.1**).

Identification of TB Suspects

PULMONARY TB SUSPECT

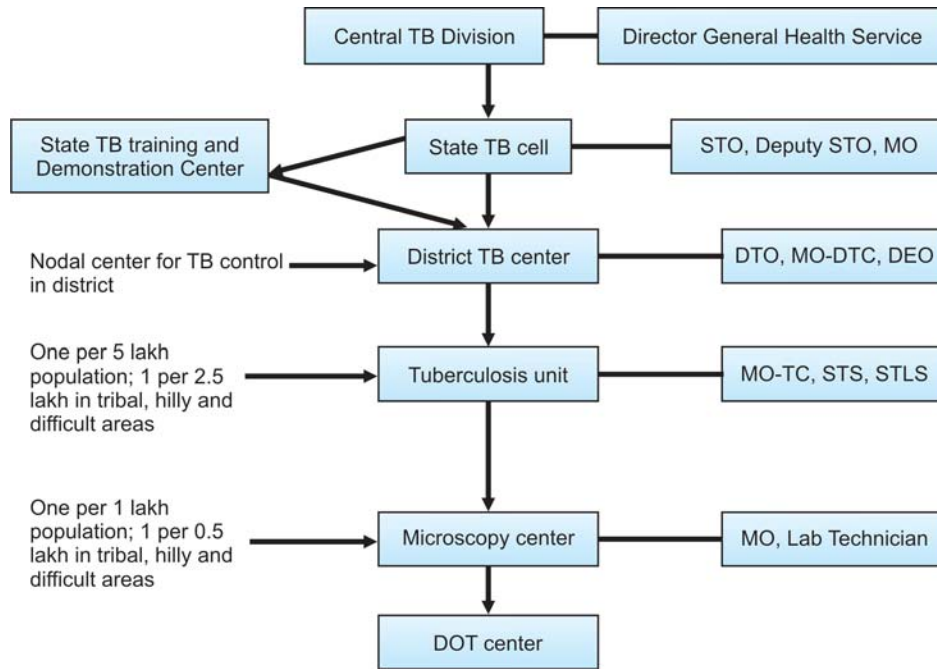
Persons with cough for two weeks or more, with or without other symptoms suggestive of TB, are identified as pulmonary TB suspects and steps are taken for sputum smear microscopy for acid-fast bacilli, for diagnosis of TB.

CASE FINDING METHODS

Sputum smear examination for AFB: Sputum from TB suspects is sent to the laboratory of RNTCP known as designated microscopy center (DMC) for sputum smear examination. This is the only way to confirm tuberculosis. There is no place for sputum culture in the RNTCP (**Fig. 16.2**).

Collection of sputum: Two sputum specimens are collected over a day or two consecutive days; one is collected on the spot and the other is an early morning

specimen collected at home by the patient. If the health facility is a DMC, one spot specimen is collected immediately on the first day and patient is given a sputum container with instructions for collection of an early morning specimen which is brought to the DMC by the patient/attendant on the second day. If the health facility is not a DMC, then the patient is given a sputum container with instructions to collect an early morning specimen and go with the sputum specimen to the DMC where the spot specimen is collected. Results of sputum tests are reported within a day.



DEO: Data Entry Operator.

Fig. 16.1: Organizational structure: Central and State level

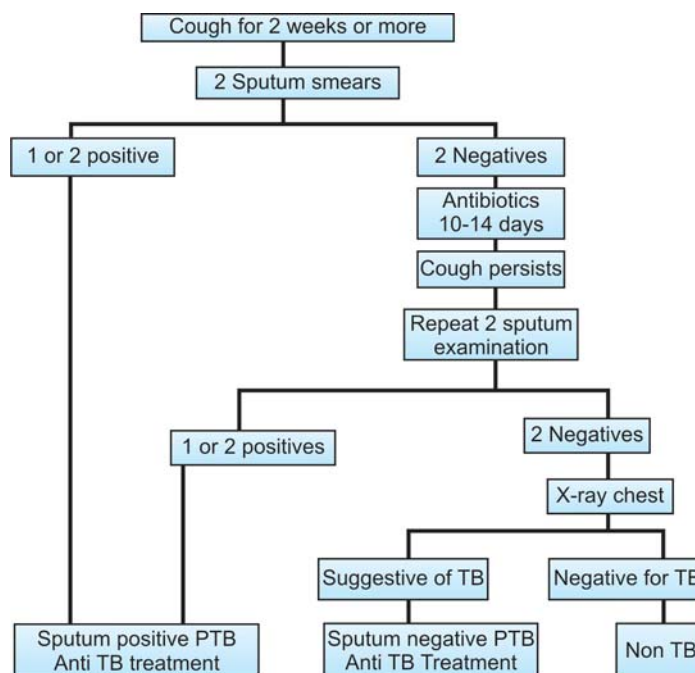


Fig. 16.2: Diagnostic algorithms for pulmonary TB

X-ray chest: Used as a supportive tool to microscopy. X-rays are necessary for the diagnosis of smear negative cases if both the samples of a repeat sputum examination after a two weeks course of antibiotic therapy are negative.

Tuberculin test: May be useful as an additional tool for diagnosing pediatric TB.

Patients suspected of having extrapulmonary TB, and patients who are contacts of sputum smear-positive patients, should have their sputum examined for AFB if they have cough of any duration.

Definitions Under RNTCP

PULMONARY TUBERCULOSIS

Smear-positive Patient

TB in a patient with at least one initial sputum smear examinations (direct smear microscopy) positive for acid-fast bacilli (AFB)

Or: TB in a patient with one sputum specimen positive for AFB and radiographic abnormalities consistent with active pulmonary TB as determined by the treating physician.

Or: TB in a patient with one sputum specimen positive for AFB and culture positive for *M. tuberculosis*.

Smear-negative Patient

A patient having symptoms suggestive of TB with at least two sputum examinations negative for AFB, and radiographic abnormalities consistent with active pulmonary TB as determined by the treating MO, followed by a decision to treat the patient with a full course of anti-TB therapy

Or: A patient whose diagnosis is based on positive culture for *M. tuberculosis* but sputum smear examinations negative for AFB.

Extrapulmonary Tuberculosis

Extrapulmonary tuberculosis (EPTB) is TB of organs other than the lungs, such as the pleura (pleurisy), lymph nodes, intestines, genitourinary tract, skin, joints and bones, meninges of the brain, etc.

Diagnosis should be based on culture-positive specimen from an extrapulmonary site, or histological or radiological, or strong clinical evidence consistent with active extrapulmonary TB followed by the treating MO's decision to treat with a full course of anti-TB therapy.

A patient diagnosed with both sputum smear positive pulmonary TB and extrapulmonary TB should be classified as a case of pulmonary TB (**Fig. 16.3**).

Diagnosis of TB in Children: Standard Case Definition ²¹

SUSPECT (HISTORY)

A child with fever and/or cough for more than two weeks, with or without weight loss or no weight gain; and history of contact with a suspected or diagnosed case of active TB disease within the last two years.

PROBABLE (HISTORY AND CLINICAL EXAMINATION)

A combination of clinical presentation, sputum examination wherever possible, chest X-ray, mantoux test (1 TU PPD RT23 with Tween 80, positive if induration >10 mm after 48–72 hours) and history of contact.

Confirmed (Laboratory Tests)

A patient with culture positive for the *Mycobacterium tuberculosis* or a patient with one or two sputum smears positive for acid-fast bacilli.

Definition of Types of Cases

NEW

A TB patient who has never had treatment for tuberculosis or has taken anti-tuberculosis drugs for less than one month.

RELAPSE

A TB patient who was declared cured or treatment completed by a physician, but who reports back to the health service and is now found to be sputum smear-positive.

TRANSFERRED IN

A TB patient who has been received for treatment into a Tuberculosis Unit, after starting treatment in another unit where s/he has been registered.

TREATMENT AFTER DEFAULT

A TB patient who received anti-tuberculosis treatment for one month or more from any source and returns to treatment after having defaulted, i.e. not taken anti-TB drugs consecutively for two months or more, and is found to be sputum smear-positive.

FAILURE

Any TB patient who is smear-positive at five months or more after starting treatment. Failure also includes a patient who was treated with Category III regimen but who becomes smear-positive during treatment.

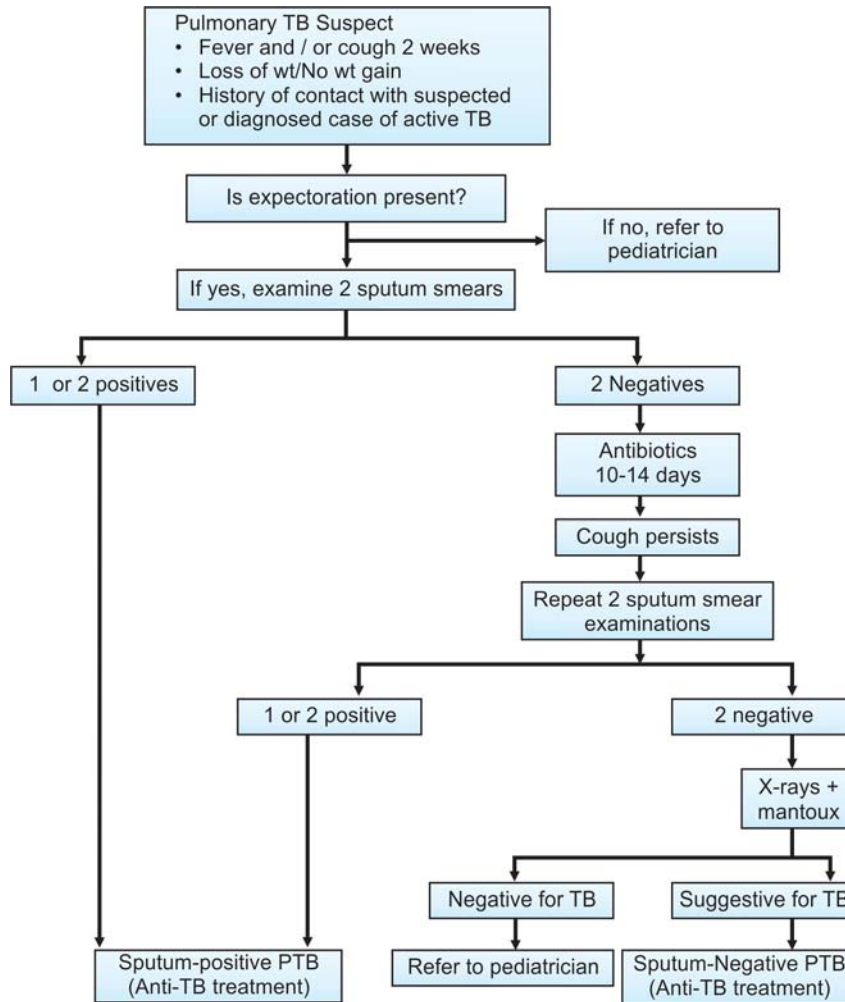


Fig. 16.3: Diagnostic algorithm for pediatric pulmonary TB

CHRONIC

A TB patient who remains smear-positive after completing a re-treatment regimen.

OTHERS

TB patients who do not fit into the above mentioned types. Reasons for putting a patient in this type must be specified.

Outcomes

CURED

Initially sputum smear positive patient who had completed treatment and had negative smears, on two occasions, one of which was at end of treatment.

TREATMENT COMPLETED

Sputum smear-positive, who has completed treatment with negative smears at the end of the intensive phase but none at end of treatment.

Or pulmonary smear-negative TB patients or extrapulmonary TB patient, who received a full course of

treatment and has not become sputum positive during or at the end of treatment.

DIED

Patient died during the course of treatment, regardless of cause.

TRANSFERRED OUT

Patient who has been transferred to another TU/district and his/her treatment outcome is not available.

Seriousness of Illness

The severity of the illness depends on the bacillary load, the extent and the anatomical site of the disease. The involvement of an anatomical site helps in classifying if the disease is severe, depending on whether it is life threatening or has high risk of developing subsequent severe handicap or both. The following forms of extrapulmonary TB and smear negative pulmonary TB are classified as 'seriously ill' (Table 16.7).

Previously this was taken into consideration in categorization to patients of sputum smear negative and extrapulmonary cases. At present it has no role.

Directly Observed Treatment (DOT)

- Directly observed treatment (DOT) is one of the key elements of the DOTS strategy, as it ensures treatment for the entire course with the right drugs, in the right doses and at the right intervals. In DOT, an observer watches over and supports the patient in taking their drugs.
- The health worker or community volunteer who administers DOT is called the 'DOT Provider'. DOT can be provided by anyone other than the patient's family members. The 'DOT center' is a place where DOT is given and is convenient to both patient and DOT provider.
- Drugs are supplied in patient-wise boxes (PWB) containing the full course of treatment, and packaged in blister packs. The PWB have a color code indicating the category (Red for CAT I, Blue for CAT II and Green for CAT III). In each PWB, there are two pouches one for intensive phase (A) and one for continuation phase (B). For the intensive phase, each blister pack contains medicines for one dose. For the continuation phase, each blister pack contains one week's supply of medication. The drugs for extension of the intensive phase (prolongation pouches) are supplied separately (**Table 16.8**).
- All doses in the intensive phase are taken under observation of the DOT provider. The patient is contacted within one day of missing a dose during the intensive phase. The dose missed on the specified day in the intensive phase is administered on the following day. In the continuation phase, at least the first dose of the week is taken under direct observation and the subsequent doses for the week are self administered. On the next scheduled visit, the empty blister pack is collected by the DOT provider before giving the next weekly dose. The patient is contacted and retrieved for treatment

TABLE 16.7: Seriously ill extra-pulmonary and smear-negative pulmonary TB

<i>Extra-pulmonary seriously ill</i>	<i>Smear-negative seriously ill</i>
<ul style="list-style-type: none"> • Meningitis • Pericarditis • Peritonitis • Bilateral or extensive pleural effusion • Spinal TB with neurological involvement • Intestinal • Genito-urinary • Coinfection with HIV • All forms of pediatric extra-pulmonary TB other than lymph node TB and unilateral pleural effusion are considered to be seriously ill 	<ul style="list-style-type: none"> • Miliary TB • Extensive parenchymal infiltration • Coinfection with HIV • Cavitory disease • All forms of pediatric sputum smear negative pulmonary TB except primary complex

TABLE 16.8: Treatment regimens

<i>Category of Treatment</i>	<i>Type of Patient</i>	<i>Regimen*</i>
Category I New cases (Red PWB)	New sputum smear-positive	2(HRZE) ₃ +
	New sputum smear-negative	4(HR) ₃
	New extrapulmonary	
	New others**	
Category II Previously Treated (Blue PWB)	Smear-positive relapse	2(HRZES) ₃ +
	Smear-positive failure	1(HRZE) ₃ +
	Smear-positive treatment after default	5(HRE) ₃
	Others***	
Non-DOTS ****	Smear-positive	2 SHE + 10 HE
	Smear-negative	12 HE

* The number before the letters refers to the number of months of treatment. The subscript after the letters refers to the number of doses per week. The dosage strengths are as follows: H: Isoniazid (600 mg), R: Rifampicin (450 mg), Z: Pyrazinamide (1500 mg), E: Ethambutol (1200 mg), S: Streptomycin (750 mg). Patients who weigh 60 kg or more receive additional rifampicin 150 mg. Patients who are more than 50 years old receive streptomycin 500 mg. Patients who weigh less than 30 kg, receive drugs as per body weight. Patients in Categories I and II who have a positive sputum smear at the end of the initial intensive phase receive an additional month of intensive phase treatment.

** Those who are new in DOTS; might have taken anti TB drugs from private practitioners clinic in a scientific dosage (other than DOTS regimen) as advised by him and they do not fall into relapse, failure or default category.

*** In rare and exceptional cases, patients who are sputum smear-negative or who have extrapulmonary disease can have Relapse or Failure. This diagnosis in all such cases should always be made by an MO and should be supported by culture or histological evidence of current, active TB. In these cases, the patient should be categorized as 'Others' and given Category II treatment.

**** Patients who refuse SCC or can not comply with the regimen, adverse reaction to rifampicin and pyrazinamide.

TABLE 16.9: Drugs in children

Drugs	Adult (mg)	Children (mg/kg)
Isoniazid (H)	600	10–15
Rifampicin (R)	450 *	10
Pyrazinamide (Z)	1500	30–35
Ethambutol (E)	1200	30
Streptomycin (S)	0.75 **	15

* Patients who weigh 60 kg or more receive additional rifampicin 150 mg.

** Patients who are more than 50 years old receive streptomycin 500 mg. Patients who weigh less than 30 kg, receive drugs as per body weight.

within a week of missing a dose in continuation phase. All the empty blister packs (of IP and CP) are retained in the patient-wise boxes (PWB).

- For adults, drugs will be given in the recommended number of pills/capsules irrespective of body weight (now adults with very low body weights can be treated with paediatric PWBs). However, for patients weighing more than 60 kg an additional capsule of rifampicin 150 mg will be added to the treatment regimen. Patients who are more than 50 years old receive streptomycin 500 mg and patients who weigh less than 30 kg receive drugs as per body weight. For children, the drugs will be given according to body weight.

Drugs and their Dosage

The most important drugs used in the treatment of TB are rifampicin (R), isoniazid (H), pyrazinamide (Z), streptomycin (S) and ethambutol (E). The recommended dosage for thrice weekly regimen in adults and children is given follow: **Table 16.9**.

Follow-up Smear Examination (Table 16.10)

Follow-up of the patients is done as detailed below:

CATEGORY I

Two smears are examined each time during follow-up. The first follow-up sputum examination is done at the end of two months of intensive phase. If both smears are negative, the patient will be put on the continuation phase. If either of the smears is positive, the intensive phase will be extended by one more month, and sputum examination will be repeated at the end of the

TABLE 16.10: Follow-up sputum smear examination during treatment

Category	SS -ve at end of IP	SS +ve at end of IP
Category I	2, 4, 6 months	2, 3*, 5, 7 months
Category II	3, 5, 8 months	3, 4*, 6, 9 months

* Irrespective of sputum smear result, patient is put on to CP phase

third month. Thereafter, the patient is put on the continuation phase regardless of the sputum result at the end of the extended intensive phase.

Subsequent follow-up smear examinations are done after two months into continuation phase and if found positive the patient is declared as a treatment failure, re-registered and started on the retreatment regimen (Cat II) afresh. If the follow-up sputum is negative, the continuation phase is completed and smear examination repeated at the end of treatment.

CATEGORY II

The first sputum smear examination is done at three months, i.e. end of intensive phase. If both smears are negative, the patient will be put on the continuation phase. If either of the samples is positive, the intensive phase of treatment will be extended by one more month, and another smear examination will be done at the end of the fourth month of treatment. Thereafter, the patient is put on the continuation phase regardless of his sputum status at the end of four months of the intensive phase.

Subsequent follow-up sputum examinations are done after two months into continuation phase. Irrespective of the results of the follow-up smear examinations, the patient continues and completes the treatment when a final follow-up sputum smear is done.

Special Situations

Hospitalization

In RNTCP, patients are treated on ambulatory basis. But when the general condition of patient is serious enough like patients with pneumothorax or large accumulations of pleural fluid leading to breathlessness; massive haemoptysis etc. then they are treated in hospitals.

Treatment of TB during pregnancy and postnatal period

- Streptomycin is never given, but all other drugs are safe during this period.
- Breast feeding is advised irrespective of the mother's TB status and mother is advised to cover her mouth, if she is smear-positive, while breastfeeding the baby.
- Chemoprophylaxis with INH is recommended for the baby if mother is sputum smear-positive.

Treatment in patients with renal failure

Streptomycin and ethambutol, if given, should be closely monitored with reduced dosage under the supervision of the treating physician.

Treatment in women taking oral contraceptive pills

Rifampicin decreases the efficiency of oral contraceptives; thus women are advised to use another method of contraception.

TB and HIV

TB is the most common opportunistic infection in people living with HIV virus. HIV- infected people are at increased

risk of TB, and again HIV is also the most powerful risk factor for progression from TB infection to TB disease. TB in turn accelerates the progression of HIV to AIDS.

However, even among HIV-infected people, TB can be cured by Directly Observed Treatment, Short-course chemotherapy (DOTS). Service linkages between ICTC and RNTCP diagnostic and treatment centres are the most important area of coordination between the HIV/AIDS and TB Control program.

Achievements of RNTCP

RNTCP has consistently achieved treatment success rate of more than 85 percent, and case detection close to the global target. However, in 2007 RNTCP for the first time has achieved the global target of 70 percent case detection while maintaining the treatment success rate of more than 85 percent.

Multi-drug-Resistant Tuberculosis (MDRTB)

MDRTB refers to strains of the bacterium which are proven in a laboratory to be resistant to at least isoniazid and rifampicin. DOTS has been proven to prevent the emergence of MDRTB, and also to reverse the incidence of MDRTB where it has emerged.²²

Causes of Drug-resistant Tuberculosis

Drug-resistant TB has microbial, clinical, and programmatic causes. From a microbiological perspective, the resistance is caused by a genetic mutation that makes a drug ineffective against the mutant bacilli. An inadequate or poorly administered treatment regimen allows drug-resistant mutants to become the dominant strain in a patient infected with TB. However it should be stressed that MDR-TB is a man-made phenomenon – poor treatment, poor drugs and poor adherence lead to the development of MDR-TB.²³

Who is an MDR Suspect?

MDR-TB Suspect can be any of the following:

- Any TB patient who fails an RNTCP Category I or III treatment regimen;
- Any RNTCP Category II patient who is sputum smear positive at the end of the fourth month of treatment or later; or
- Close contacts of MDR-TB patients who are found to have smear positive pulmonary TB (PTB) disease

What is DOTS Plus

Traditionally, DOTS Plus refers to DOTS programs that add components for MDR-TB diagnosis, management and treatment. These guidelines promote full integration

of DOTS and DOTS-Plus activities under the RNTCP, so that patients with MDR-TB are both correctly identified and properly managed under the recommendations set out in this document.²³

Components of DOTS Plus

- Sustained political and administrative commitment
- Diagnosis of MDR-TB through quality-assured culture and drug susceptibility testing (DST)
- Appropriate treatment strategies that utilize second-line drugs under proper management conditions
- Uninterrupted supply of quality assured anti-TB drugs.
- Recording and reporting system designed for DOTS-Plus programmes that enable performance monitoring and evaluation of treatment outcome.

Treatment of MDR-TB

RNTCP will be using a **Standardized Treatment Regimen (Cat IV)** for the treatment of MDR-TB cases (and those with rifampicin resistance) under the program. Cat IV regimen comprises of six drugs-kanamycin, ofloxacin (levofloxacin)[†], ethionamide, pyrazinamide, ethambutol and cycloserine during six to nine months of the Intensive Phase and four drugs-ofloxacin (levofloxacin), ethionamide, ethambutol and cycloserine during the 18 months of the Continuation Phase. *p*-aminosalicylic acid (PAS) is included in the regimen as a substitute drug if any bactericidal drug (K, Ofl, Z and Eto) or two bacteriostatic (E and Cs) drugs are not tolerated (**Table 16.11**).^{23,24}

TABLE 16.11: Treatment regimens

Category of Treatment	Type of Patient	Regimen
Category IV	MDR-TB cases	6 (9) Km Ofx (Lv _x) Eto Cs Z E + 18 Ofx (Lv _x) Eto Cs E

Extensively-drug-Resistant Tuberculosis (XDR-TB)

This is defined as resistance to at least isoniazid and rifampicin, plus resistance to any of the fluoroquinolones and any one of the second line injectable aminoglycoside drugs like amikacin, kanamycin, capreomycin.²⁴

Category V Regimen

This regimen is given XDR-TB. The drugs are Linezolid, Moxifloxacin, INH, Clarithromycin, Capreomycin, Ethambutol, clofazimine, amoxicillin/clavulanate, thioacetazone, imipenem/cilastatin and pyrazinamide. These drugs are given daily for 3 years.

Stop TB Strategy, the Global Plan to Stop TB, 2006–2015

WHO launched new Stop TB Strategy in 2006, which is based upon six important strategies as follows:

1. Pursuing quality DOTS expansion and enhancement, by improving the case finding and cure through an effective patient-centred approach to reach all patients, especially the poor.
2. Addressing TB-HIV, MDR-TB and other challenges, by scaling up TB-HIV joint activities, DOTS Plus, and other relevant approaches.
3. Contributing to health system strengthening, by collaborating with other health programmes and general services
4. Involving all health care providers, public, nongovernmental and private, by scaling up approaches based on a public-private mix (PPM), to ensure adherence to the International Standards of TB care.
5. Engaging people with TB, and affected communities to demand, and contribute to effective care. This will involve scaling-up of community TB care; creating demand through context-specific advocacy, communication and social mobilization.
6. Enabling and promoting research for the development of new drugs, diagnostic and vaccines. Operational Research will also be needed to improve programme performance.

Millennium Development Goals in Relation to TB Control

Goal 6—To combat HIV/AIDS, malaria and other diseases.

Target 8—To have halted by 2015 and begun to reverse the incidence of malaria and other major diseases, including tuberculosis.

Indicators for Target 8 to be used to evaluate the implementation and impact of TB control:

Indicator 23: Between 1990 and 2015, to halve the prevalence and death rates associated with tuberculosis; and

Indicator 24: By 2005, to detect 70 percent of new smear positive TB cases arising annually, and to successfully treat 85 percent of these cases.

Special Initiatives

PUBLIC PRIVATE MIX (PPM)

India has the largest private sector in the world that manages a considerable proportion of tuberculosis cases. Tuberculosis is encountered at all levels and by all types of health services ranging from primary health care services to the highly specialized hospitals in the different health care sectors. PPM includes Public-public as well as Public-private collaborations. The involvement

of other sectors is important to improve the case detection rates under DOTS and successfully treat additional numbers of TB patients.

The other health providers involved in PPM are government health facilities outside state health departments, medical Colleges, private providers, NGO and other corporate sectors.

TOTALLY DRUG RESISTANT TUBERCULOSIS (TDR-TB)²⁵⁻²⁷

The term TDR-TB refers to resistance to all first-line (FLD) and second-line anti-TB drugs (SLD). While the concept of total drug resistance is easily understood in general terms, but in practice, *in vitro* drug susceptibility testing (DST) is technically challenging.

Although consensus has been reached on DST that define MDR and XDR-TB, but data on the reproducibility and reliability of DST for the remaining SLDs are either much more limited or have not been established, or the methodology for testing does not exist.

Thus the prognostic relevance of *in vitro* resistance to drugs without an internationally accepted and standardized drug susceptibility test therefore remains unclear.¹⁰ For these reasons, the term “totally drug resistant” tuberculosis is not yet recognized by the WHO. For now these cases are defined as extensively drug resistant tuberculosis (XDR-TB), according to WHO definitions.²⁸

MDR-TB: Resistance to isoniazid and rifampicin, with or without resistance to other first-line drugs (FLD)

XDR-TB: Resistance to at least isoniazid and rifampicin, and to any fluoroquinolone, and to any of the three second-line injectables (amikacin, capreomycin, and kanamycin)

TDR-TB: Resistance to all first-line anti-TB drugs (FLD) and second-line anti-TB drugs (SLD)

WHO is organizing an Expert Group Meeting in March, 2012 to assess additional data on DST accuracy obtained since 2008. This meeting will be expanded to include a consultation on possible definitions for “totally drug-resistant” TB.²⁸

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Acute Respiratory Infections ICD-J22

Acute respiratory infections constitute a leading cause of morbidity and mortality in children.¹ The World

Health Assembly resolved in 1976 to give priority to this area. The ARI control program was launched in India in the eighties. It was later merged with the child survival and safe motherhood program.² The guidelines for ARI used in India are based upon those issued by the WHO.³ With the launch of the Reproductive and Child Health Program (RCH) in 1997, the components covered under the CSSM program have been incorporated in the RCH program. ARI control in children now forms a part of the RCH program.

Acute respiratory infections (ARI) indicate an infection of any part of respiratory tract of less than 30 days duration and otitis media of less than 14 days duration. It includes acute episode of running nose (cold), cough, ear discharge, hoarseness of voice, breathing difficulty, fast breathing and chest indrawing with or without fever. On the other hand, chronic cough is one that lasts for 30 days or more. The common causes of chronic cough are tuberculosis, asthma, foreign body, pertussis, HIV infection etc.

CLASSIFICATION OF ARI

- Upper respiratory tract infections (AURI) include common cold, pharyngitis, laryngitis, tracheitis, epiglottitis and otitis media.
- Lower respiratory tract infections (ALRI) include bronchitis, bronchiolitis and pneumonias.

MAGNITUDE OF THE PROBLEM

7,50,000 children below five years of age die of ARI in India every year, i.e. 2000 deaths per day or 85 deaths per hour. The risk of an Indian child dying of ARI is 30 to 75 times more than that of his counterpart in the developed world. In India, ARI accounts for 14.3 percent of deaths during infancy and 15.9 percent of deaths during the age one to five years. A child suffers five to eight episodes per year in the urban and two to three episodes per year in the rural areas.

Acute Respiratory Infection (ARI) is currently the leading cause of death in young children in low income countries; the form of ARI most often leading to death in children is pneumonia. It is estimated that, annually, there are 2000 million episodes of ARI of which 1 out of 50 are cases of pneumonia; between 10 and 20 percent of these die. The World Health Organization (WHO) estimates that one-third of all deaths in children below the age of five years (4.3 million deaths in real terms in 1993) are due to ARI. These deaths include those resulting from neonatal pneumonia, as well as from pneumonia complicating measles, pertussis and HIV infection. Contributing factors associated with a large number of pneumonia deaths are low birth weight and severe malnutrition.

The total mortality rate in children in any community is a reliable indicator of the amount of ARI mortality

because ARI accounts for such a high proportion of all deaths. Thus by studying the infant mortality rate (IMR), population figures and number of deaths in the under-five population, it is possible to get an idea of the distribution of ARI by region and country. The WHO has developed a list of priority countries based on their current infant mortality rates. Target countries are those with an IMR of over 40 per 1000 live births. Approximately 57 percent of the world's children live in such countries; another 27 percent live in countries with an IMR of between 20 and 40 and only 16 percent in countries with an IMR of less than 20. The highest death rates for ARI are seen in Africa, especially sub-Saharan countries, followed by Asia (excluding China) and then by Latin America and China, and with much lower rates in North America and Europe.^{3a}

ARI comprises 25-30 percent of hospital consultations and 25 percent of total hospital admissions. However, the incidence of ARI is similar in industrialized and developing countries.¹

AGENT FACTORS

Acute respiratory infections are caused by a variety of pathogens including bacteria and viruses. The manifestations include influenza, sinusitis, acute otitis media, nasopharyngitis, tonsillitis, epiglottitis, laryngitis, tracheitis, acute bronchitis, bronchiolitis and pneumonia. Some of the respiratory infections like measles, diphtheria, whooping cough and childhood tuberculosis are preventable with the help of immunizations included in the UIP.

HOST FACTORS

Low birth weight: Infants born with low birth weight, once infected, are more prone to death from pneumonia. A study from India has demonstrated that LBW infants had significantly lower case fatality rate in villages where ARI control program was in operation compared to a control area.⁴

Malnutrition: The average duration of ARI illness in a malnourished child is significantly longer. The complications are more frequent and the prognosis more grave; for instance, pneumonia may be twenty times more frequent in malnourished children as compared to normal children. Breastfeeding protects against severe respiratory infections. Humoral antibodies and other host resistance factors present in human milk play a crucial role against both viral and bacterial agents. Xerophthalmia may be associated with higher incidence of ARI because vitamin A is essential for the functional integrity of respiratory mucosa.

Lack of immunization: Pneumonia is a common complication associated with measles and whooping

cough which can be prevented by appropriate immunization.

Antecedent viral infection: Such infections act by impairing the child's immune status. The bronchial epithelium is damaged and thus the clearing of the bacterial agent is impaired.

Environmental Factors

Air pollution: Air pollution, both indoor and outdoor, is directly associated with an increased incidence of ARI. The inhalants in polluted air cause damage to tracheo-bronchial mucosa and bring about ciliary paralysis which might increase susceptibility to severe infection.

Passive smoking: Passive smoking predisposes a child to respiratory illness. Passive exposure to smoke in childhood has an important bearing on the development of respiratory function which, in turn, may predispose a child to increased risk from environmental agents later in life.

Pollution from biomass fuels: Heavy exposure to smoke from cooking and heating fires predisposes a child to severe ARI.

Overcrowding: In conditions of continued close contact in crowded families, an increased secondary attack rate for respiratory infections has been established.

TIME FACTOR IN PROGNOSIS OF ARI

Respiratory infections, if treated early and effectively, can be completely cured in nearly all cases with normal life expectancy, which is often not possible with other systemic diseases. There is empirical evidence that the high mortality in acute infections, including those affecting the respiratory system, is mainly attributable to gross delay in institution of effective therapy.

ARI Component of RCH Program^{2,5}

GOAL

The goal is to reduce child deaths due to pneumonia.

Program Coverage

It includes:

- Prevention of pneumonia cases through measles and BCG immunization and vitamin A prophylaxis
- Identification of pneumonia in children
- Promotion and education on home remedies, and
- Early referral for proper treatment and preventing death.

Strategy

- Reduce deaths due to pneumonia by standard case management by workers as well as medical practitioners at all service facilities.

- Equip mothers in early recognition of fast and difficult breathing and seeking referral.
- Promote correct home care for ordinary cough and cold through education of mothers.
- Reduce inappropriate use of antibiotics in treating ARIs other than pneumonia in children.
- Sustain high coverage with immunization especially measles, DPT and BCG.
- Implementation to be done as an integral part of the primary health care system, closely linked with immunization outreach services, promotion of breastfeeding and use of ORT for diarrhoea management.
- Surveillance of pneumonia cases and deaths. Training of health workers, by medical officers, so that the workers should be able to (a) assess children with cough and cold, (b) advise parents properly for home care, (c) initiate correct case management, and (d) refer cases with serious disease to a health facility equipped to handle such emergencies.

Standard Case Management—Medical Officers' Role

Traditionally, medical officers have been trained to use auscultation of the chest, laboratory investigations and chest X-ray to diagnose pneumonia. It has now been shown that *rapid respiratory rate, chest in-drawing and inability to drink* are, in most cases, more reliable and practical in making a diagnosis of pneumonia. The pathognomonic value of these selected signs has been well established. Assessment of these signs is critical for correct case management.

- Routine use of antimicrobials, cough syrups containing ephedrine, codeine, atropine or alcohol, medicated nasal or ear drops are discouraged in the treatment of the child with uncomplicated acute upper respiratory infections. Health centers and hospitals should stop purchase of commercial cough syrups.
- Only saline nasal drops are recommended for running or blocked nose.
- Upper respiratory infections are excluded because most of them are self-limiting in nature and need only symptomatic treatment.

CLINICAL ASSESSMENT

History taking include: Age, duration of cough and fever, antecedent history of measles or any other disease, inability to drink, drowsiness, convulsing fast breathing, chest indrawing, abnormal sounds (e.g. stridor, grunting), immunization status and treatment if any.

Criteria for Diagnosis

- **Respiratory rate:** The respiration rate may be counted by looking to exposed abdominal/lower

chest wall movement. Counting should be made for 1 minute when the child is calm. However, if the rate is more than 60/minute in a young infant (<2 months age), a repeat count should be made. Fast breathing is a sign of pneumonia. Some time fast breathing may be absent in severe pneumonia if the child become exhausted and effort need to expand the lung is too great.

Fast breathing is present when the respiratory rate is:

- 60 or more in a child less than 2 months of age.
- 50 or more in a child 2 to 12 months of age.
- 40 or more in a child 1 to 5 years of age

- **Lower chest wall indrawing:** In normal breathing, the whole chest wall including the abdomen move out when the young infant breathes in. When chest indrawing is present, the lower chest wall goes in during inspiration. Only the soft tissue movement between the ribs or above the clavicle during inspiration is not chest wall indrawing. Chest indrawing should be examined in a quite/clam baby or while sleeping. Mild chest indrawing is normal in a young infant because the chest wall is soft. Severe chest indrawing is very deep and easily detected. Severe chest indrawing is a sign of pneumonia and is serious in a young infant.
- Stridor is a harsh noise during inspiration, which is due to narrowing of upper respiratory passage (oropharynx, subglottis or trachea). The conditions are termed as croup commonly. If the obstruction is severe, stridor may also occur during expiration.
- Wheeze is a high-pitched whistling sound near the end of expiration. It is caused by spasmodic narrowing of the distal airways. During the first 2 years of life, wheezing is mostly caused by acute viral respiratory infections such as bronchiolitis or coughs and colds. After two years of age, usually it is due to asthma. Sometimes children with pneumonia may present with wheeze. It is important always to consider pneumonia as a diagnosis, particularly in the first two years of life.
- **LOOK for nasal flaring:** Nasal flaring is widening of the nostrils when the young infant breathes in.
- **LOOK and LISTEN for grunting:** Grunting is the soft, short sound a young infant makes when breathing out. Grunting occurs when an infant is having trouble breathing.
- Body temperature: Fever and Hypothermia
- Nutritional status
- Cyanosis

CLASSIFICATION OF ARI

For the practical purposes the cases are classified as followed, which vary in different age group.

Child of aged 2 months to 5 years:

- No pneumonia, cough or cold
- Pneumonia
- Severe pneumonia
- Very severe illness

Young infant (<2 months of age):

- No pneumonia, cough or cold
- Severe pneumonia—any pneumonia in young infant is considered as severe.
- Very severe illness

Management of Cases (2 Months–5 Years)**For no pneumonia, cough or cold:***Home remedy*

- Soothe the throat and relieve the cough with a safe remedy, such as a warm, sweet drink.
- Clear secretions from the child's nose before feeds using a cloth soaked in water
- Relieve high fever with paracetamol
- Following medication are not indicated
 - Antibiotic is (they are not effective and do not prevent pneumonia)
 - Medicated nose drops
 - Remedies containing atropine, codeine or codeine derivatives, or alcohol may be harmful.

Advise the mother to:

- Continue feeding
- Watch for fast or difficult breathing and return, if either develops
- Return if the child becomes sicker, or is not able to drink/breast feed.

Pneumonia

Pneumonia is usually caused by viruses or bacteria, which may be fatal if remain untreated. Pneumonia is classified as very severe, severe or nonsevere, based on the clinical features, with specific treatment for each of them (**Table 16.12**). Pneumonia is usually caused by viruses or bacteria. Antibiotic therapy is needed in all cases. Cotrimoxazole is the drug of choice for pneumonia. Severe and very severe pneumonia require additional treatment, such as oxygen and other supportive treatment.

Diagnosis

- Cough or difficult breathing
- Fast breathing
- Signs of severe or very severe pneumonia absent.

Treatment

- May be treated at home
- Cotrimoxazole (4 mg/kg trimethoprim and 20 mg/kg sulfamethoxazole twice a day) or amoxicillin (25 mg/kg 2 times a day) for two days and rest of doses at follow up visit. Cotrimoxazole is not routinely recommend for an infant below two years; this is given for severe pneumonia. Pneumonia may be treated by health worker at

TABLE 16.12: Classification of the severity of pneumonia (2 month – 5 years)

<i>Sign or symptom</i>	<i>Classification</i>	<i>Place of treatment and action</i>
<ul style="list-style-type: none"> • Cough • No fast breathing • No chest indrawing 	No pneumonia, cough or cold	<ul style="list-style-type: none"> • Home remedy: Soothe throat and relieve cough with warm, sweet drink, Clear secretions from the child's nose using a cloth soaked in water • Relieve high fever with paracetamol • No antibiotics is required (neither effective nor prevent development of pneumonia) • Remedies containing atropine, codeine or codeine derivatives, or alcohol may be harmful • Advise the mother to continue feeding, watch for fast or difficult breathing and return, if either develops, return if the child becomes sicker, or is not able to drink /breast feed
<ul style="list-style-type: none"> • Fast breathing 	Pneumonia	Home care / Care at health center Give appropriate antibiotic for 5 days Follow-up in 2 days Advise the mother when to return
Lower chest wall indrawing	Severe pneumonia	<ul style="list-style-type: none"> • Refer urgently to hospital with first dose of antibiotic • Give recommended antibiotic
Pneumonia along with danger sign <ul style="list-style-type: none"> • Not able to drink • Convulsion • Abnormally sleepy • Stridor or wheeze in a calm child • Central cyanosis • Severe under nutrition. 	Very severe disease	<ul style="list-style-type: none"> • Admit to hospital • Give recommended antibiotic

TABLE 16.13: Treatment of pneumonia at home or subcenter with cotrimoxazole

Age/ Weight	Pediatric tablet (Trimethoprim 20 mg and Sulfamethoxazole 100 mg)	Syrup (Each 5 ml contain Trimethoprim 40 mg and Sulfamethoxazole 200 mg)
<2 months	One tablet twice daily	Half spoon (2.5 ml) twice daily
2–12 months	Two tablets twice daily	One spoon (5 ml) twice daily
1–5 years	Three tablets twice daily	Three spoon (7.5 ml) twice daily

home or subcenter with cotrimoxazole according to following schedule.

Give the first dose at the clinic and teach the mother how to give the other doses at home (**Table 16.13**).

FOLLOW-UP

Encourage the mother to feed the child. Advise her to bring the child back after two sdays, or earlier if the child becomes sicker or is not able to drink or breastfeed. If the breathing has improved (slower), there is less fever, and the child is eating better, complete the three days of antibiotic treatment. If the breathing rate, fever and eating have not improved, change to the second-line antibiotic and advise the mother to return again in two days. If there are signs of severe or very severe pneumonia need institutional care.

Criteria for Diagnosis

- The basic criterion for diagnosis of pneumonia is based on the counting of respiratory rate. A breathing rate of 60 per minute or more in an infant less than two months of age, 50 or more in an infant 2 to 12 months of age and 40 or more in children 1 to 5 years of age suggests pneumonia. In each case respiratory rate should be carefully counted in a resting child for a full minute. In a child whose respiratory rate exceeds these limits, a second count should be done before a diagnosis is made.
- Children breathing at rates lower than mentioned above are considered to have no pneumonia. Home

treatment alone will be recommended in such cases. Examples are locally accepted remedies made from household ingredients (honey, ginger, tulsi, hot water) or a suitable bulk cough mixture made in the dispensary. Fever control with paracetamol, continued feeding and adequate fluids should be ensured.

- In the event that respiratory rates are above the indicated levels, the following action should be taken: Infants aged zero to two months, with a respiratory rate of 60 per minute or more should be referred immediately to a health care facility where a doctor is available for further evaluation and treatment. No treatment should be offered by paramedical workers for these young children in view of the high danger of respiratory disease in this age group. The dose of cotrimoxazole (pediatric) in this age group is 1 tablet twice a day for five days (**Table 16.14**).

It is important to remember that in a child with severe pneumonia, the respiratory rate may actually slow down as a result of exhaustion and advanced disease. Therefore, the presence of chest indrawing and other dangerous signs should take precedence over respiratory rate as diagnostic criterion.

At the PHC, after further evaluation, parenteral antibiotic is started. If the case is very severe, the child should be sent onward to another hospital facility where round the clock nursing, oxygen, intravenous drugs and laboratory or radiological investigations are available.

Viewed in the light of the strategy of the national ARI control program, the findings of a recent survey are alarming.⁶ The survey was conducted by the Indian Medical Association to study the practices of its members in relation to ARI. Out of 891 physicians studied, 71 percent relied primarily on auscultation and only 19 percent on counting of respiratory rate for diagnosing ARI. 54 percent used antibiotics even in URI. More than half did not use cotrimoxazole which is the cheapest and most effective agent with the broadest spectrum. The urgent need for proper orientation and training of doctors is obvious. Along with this, it is also important that mothers understand the appropriate management decisions. The health education measures aim at propagating the following messages:

TABLE 16.14: Dose schedule for cotrimoxazole(*) in a suspected case of pneumonia

Dose/Frequency (for each dose)	Form	Amount per dose (in no. of tablets, or ml of syrup) according to body weight in kg		
		3–5 kg	6–9 kg	10–19 kg
4 mg of Trimethoprim per kg every 12 hours	Adult single strength tablet containing 80 mg TMP + 400 mg of SMX	0.25**	0.5	1
4 mg of Trimethoprim per kg every 12 hours	Pediatric tablet containing 20 mg of TMP + 100 mg of SMX	1**	2	3
4 mg of Trimethoprim per kg every 12 hours	Syrup containing 40 mg of TMP + 200 mg of SMX per 5 ml	2.5**	5	7.5

*Cotrimoxazole = Trimethoprim (TMP) + Sulfamethoxazole (SMX)

**If the child is less than 1 month old, give 1/2 pediatric tablet or 1.25 ml syrup twice daily. Avoid cotrimoxazole in neonates who are premature or jaundiced.

- Most children with cough *do not* need antibiotics.
- Children with cough and difficult breathing do need treatment from a health worker quickly.
- Fast breathing and chest indrawing are signs of severe ARI and may require hospitalization.
- Breastfeeding should be promoted.
- A child with cough should be given food and fluids.
- A child with cough should be kept warm but not overwrapped.
- Immunization can prevent some serious kinds of cough.
- Passive smoking and domestic air pollution should be reduced.

The health education campaign is expected to lead to recognition of mild, moderate and severe ARI by mothers, immunization of children at right age, maintenance of nutrition and early institution of appropriate antibiotic therapy in moderate and severe ARI cases.

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Water and Food-borne (Alimentary) Infections

The mode of spread of the alimentary infections in general and their classification have already been described in Chapter 12. In this chapter will be described the alimentary infections caused by bacteria, protozoa, viruses and worms, in that order. A general classification of various diseases related to water is given in **Table 17.1**. The list of food-borne diseases is given in **Table 17.2**.

Cholera and Diarrhea

Cholera (ICD A00.9)

HISTORY AND PREVALENCE

The world incidence of cholera has been divided into three phases.¹ The first is the pre-1817 period when cholera was limited to India, particularly Bengal. The second phase (1817-1923), called the pandemic phase, witnessed six pandemics, all starting from India and spreading over several continents, including South East

Asia, China, Middle East, USSR, Europe and Africa. The third phase, starting in 1923, was once again marked by confinement of cholera to India and the East. To these three phases may be added the fourth phase which started in 1961 with the onset of the still continuing seventh pandemic.

The seventh pandemic started from an endemic focus on an island in Indonesia in 1961. It was caused not by the classical cholera vibrio but by El Tor vibrio. By 1965, El Tor completely replaced classical *V. cholerae* in India.² The worst year of this pandemic was 1970 when it involved some parts of all the continents except America.

From 1948 onwards 98 percent of the world cases have occurred in India, Pakistan and Bangladesh.

TABLE 17.1: Water-borne infections³

Types	Diseases
Direct water-borne	Cholera, diarrhea, enteric fever, dysentery, hepatitis
Through intermediate vector	Schistosomiasis, guinea worm

TABLE 17.2: Food-borne diseases⁴

Diseases	Causative organisms	Vectors or means of spread
<i>Bacterial</i>		
Anthrax	<i>Bacillus anthracis</i>	Contaminated meat
Botulism	<i>Clostridium botulinum</i>	Anaerobic growth of spores in inadequately processed, canned or bottled food
Cholera	<i>Vibrio cholerae</i>	Contaminated water or food; flies
Dysentery, bacillary	Various species of genus <i>Shigella</i>	Contaminated water or food; flies
Paratyphoid fever	<i>Salmonella spp</i>	Contaminated food, particularly milk, milk products, shellfish; flies
Salmonellosis	<i>Salmonella spp</i>	Contaminated food, particularly meat and meat products, milk and milk products
Staphylococcal infections	<i>Staphylococcus spp</i>	Food contaminated from human sources
Streptococcal infections	<i>Streptococcus spp</i>	Food contaminated from human sources
Typhoid fever	<i>Salmonella typhi</i>	Contaminated water and food, particularly milk, milk products and shellfish
<i>Parasitic</i>		
Amebiasis	<i>Entamoeba histolytica</i>	Contaminated food, particularly vegetables eaten raw; water
Ascariasis	<i>Ascaris lumbricoides</i>	Contaminated vegetables eaten raw
Clonorchiasis	<i>Clonorchis sinensis</i>	Raw or partially cooked infected fresh water fish
Diphyllobothriasis	<i>Diphyllobothrium latum</i>	Raw or partially cooked infected fresh water fish
Fasciolopsiasis	<i>Fasciolopsis buski</i>	Contaminated vegetables eaten raw
Hydatidosis	<i>Echinococcus granulosus</i>	Contaminated food and water
Teniasis and cysticercosis	<i>Taenia saginata</i>	Infected beef
	<i>Taenia solium</i> and its larval form	Infected pork
	<i>cysticercus cellulosae</i>	
Trichinellosis	<i>Trichinella spiralis</i>	Infected pork
Trichuriasis	<i>Trichuris trichuria</i>	Contaminated food

Classical severe cases are now uncommon. Most cases now are mild with diarrhea as the only presenting feature. In India cholera is endemic in India in several states, notably Bengal, Bihar, Orissa, Assam and Tamil Nadu.¹ However, it has spread to some other states also during the last few years.

There are two types of epidemics, explosive and protracted. An explosive epidemic originates from one single polluted source such as a well and lasts for 1 to 5 days only. A protracted epidemic is due to repeated pollution of a large body of water such as a river, tank, or canal. It goes on for several weeks.

Case fatality varies from 10 to 80 percent. Rate above 50 percent may be found in severe untreated cases. In cases treated properly, less than 1 percent may die.⁵ Usually a few mild and missed cases occur at the beginning and end of an epidemic and severe ones are seen in the middle. Early cases are often mistaken for food poisoning and diarrhea due to other causes.

CAUSATIVE AGENT

The causative agent is *Vibrio cholerae* O-group 1 of the immunologically indistinguishable classical and El Tor biotypes. There are two serotypes—Ogawa and Inaba. The species *V. cholerae* also includes some vibrios that are Biochemically indistinguishable from the above but which do not agglutinate in *Vibrio* O-group 1 antiserum. These are often referred to as nonagglutinating vibrios (NAGs) or as noncholera vibrios (NCVs) and are now included in the species *V. cholerae*. Some strains of these do produce the enterotoxin and cause cholera like disease but such cases are usually sporadic and do not cause epidemics. The most common organism isolated at present is El Tor of Ogawa serotype.

The classical or true cholera vibrio was discovered by Koch as a highly motile, vibrating, comma shaped vibrio with a single flagellum. It is nonhemolytic in character. The El Tor was isolated in El Tor (Egypt), in 1905. The disease caused was called paracholera and the strain was hemolytic. On assuming pandemic character, it has become nonhemolytic in recent years and is now distinguished from classical vibrio by resistance to phage IV and polymixin B and the ability to agglutinate chicken red blood cells. Epidemiologically, El Tor differs from the classical vibrio in being resistant to environmental factors and antibiotics. It is hence more easily detectable in stools and in water. El Tor infection produces less severe symptoms.

Two fractions are extracted from the vibrios by phenol, a specific antigen and a group antigen. The specific or 'O' antigen is a phenol insoluble fraction extracted from true cholera and El Tor vibrios. It is a polysaccharide that gives specific agglutination and precipitation reactions with serum containing true cholera and El Tor antibodies. Extracts from NAG vibrios do not show this specific relationship. The group or 'H'

antigen is a phenol soluble fraction. It is a protein that gives positive reaction with all *V. cholerae* sera.

A new strain *Vibrio cholerae* type 139 (Bengal strain) was identified in Chennai in October 1992. It is believed to have originated in West Bengal. More than one lakh cases have been diagnosed to be infected by this strain in Bangladesh alone. This fast spreading strain mainly affects adults. It is feared that this strain may spread fast to cause the eighth cholera pandemic.⁶

VIABILITY

V. cholerae tolerates poorly such environmental stresses as drying, exposure to sunlight and competition with other organisms. It cannot survive in or on fomites for long. Water is found to be contaminated only in association with infected individuals; contaminated water will become free of vibrios within a few days if such individuals are removed. There are indications that the causative organism including El Tor may survive in water for long periods in a free state, particularly in inter-epidemic periods.⁷

Vibrios in tank or well water stored in laboratory die within 7 to 13 days (1 to 2 days only if the water contains other bacteria, such as the ones present in river water). *Vibrio cholerae* remain viable for several days in food that is alkaline and moist, provided competing organisms do not overgrow it. They can survive for 2 to 3 weeks in stools not exposed to the sun. Temperature above 55°C kills the organisms while growth is arrested below 16°C. *V. cholerae* can survive in ice for 4 to 6 weeks. The survival time of El Tor vibrios passed by the carriers is much shorter than that of the organisms passed by the cases. Organisms are easily killed by coal tar disinfectants, chlorine and potassium permanganate.

SOURCE OF INFECTION

The only known reservoirs are the infected persons such as:

- Those late in the incubation period
- The typical cases
- The mild and missed cases having only diarrhea
- Convalescent carriers for 7 to 10 days or longer, and
- The contact carriers or asymptomatic individuals.

The ratio of severe cases to mild cases and contact carriers is 1:5 to 1:10 for classical cholera and 1:25 to 1:100 for El Tor cholera as already mentioned.²

Water is not the source of infection but only a temporary or secondary reservoir. However, it is the most important medium of transmission.

Period of Communicability

The patient is infective during the later part of incubation period and during the periods of disease and convale-

scence. Convalescence usually lasts 7 to 10 days. Sometimes convalescent carriers are infectious for 2 to 3 weeks. Convalescents with El Tor infection may pass the organisms for a much longer period. Rarely, long-term carriers are seen in those in whom the gall bladder is infected.

MODES OF TRANSMISSION

Water plays an important and crucial role in transmission and maintenance of cholera cycle in man, but food and other environmental factors are also important, particularly in case of El Tor.⁸ Major modes of transmission are:

- Transmission through water when sources such as wells, ponds, lakes, streams and rivers are contaminated by infected fecal matter.
- Transmission through foods and drinks contaminated by an infected person, particularly during an outbreak.
- Secondary transmission by direct contact.

SUSCEPTIBILITY AND RESISTANCE

Cholera affects individuals of the lower socioeconomic groups because of their poorer sanitary conditions. Adult males are affected more during earlier stages of the epidemic, but no sex difference is seen later on. More adults than children are affected in an epidemic but the disease is more severe in the latter. This is because people acquire immunity as they grow older. Gastric acid kills cholera organisms and susceptibility to cholera is increased when gastric acidity is decreased.⁹ Acquired immunity through infection or inoculation is short lived and uncertain.

INCUBATION PERIOD

1 to 5 days, usually 12 hours to 2 days.

CLINICAL PICTURE

Cholera vibrios are acid-sensitive, so the first line of defence is acid in the stomach. They multiply rapidly in the small bowel where pH range is 7 to 8 and produce an adequate amount of exotoxin that causes electrolyte secretion in the intestine. Thus, the clinical picture is the result of gastrointestinal loss of an isotonic fluid, sometimes at the rate of 1 liter per hour, having the following electrolyte concentration:

The classical clinical picture of cholera is described in three stages (**Table 17.3**).

Stage of Profuse Watery Evacuations

Classical cholera starts suddenly with pain in the abdomen and large watery motions which contain fecal matter at first but later become thinner and thinner, looking like

TABLE 17.3: The classical clinical picture

Electrolytes	Mean value	SD (standard deviation)
Sodium	126 mEq/L	9
Potassium	19 mEq/L	9
Bicarbonate	47 mEq/L	10
Chloride	95 mEq/L	9

rice water, containing flakes or mucus. There is usually no griping or tenesmus. Diarrhea continues for 2 to 6 days. As many as 40 motions might occur in one day. Diarrhea is followed by projectile vomiting in 80 percent cases but vomiting may even precede diarrhea. It occurs without effort, nausea or retching.

Stage of Collapse

Purging and vomiting gradually become small and less frequent. Signs of marked dehydration are apparent such as apathy, cyanosis, sunken eyes, anxious look, excessive thirst, husky voice and cold and clammy skin, showing subnormal surface temperature (up to 35°C) while rectal temperature may be as high as 41°C. Loss of skin turgor and muscle cramps may also occur. Systolic blood pressure falls below 70 mm, urine is suppressed and the pulse becomes fast, weak and thready or may even disappear.

Stage of Recovery or Death

The patient recovers or dies within a few days. Recovery occurs if the attack is mild and treatment is timely and effective. Skin becomes turgid and warm, pulse and blood pressure improve, oral fluids are retained and the patient starts passing urine. He may even become constipated. The general appearance improves. In the alternative, the stage of collapse passes onto coma and death. Two important causes of death are acute renal failure (more in adults) and hypokalemia (more in children).

Fever commonly occurs in children but rarely in adults. Convulsions may occur.

Cholera cases, particularly the early ones, are often mistaken with diarrhea due to other causes and with food poisoning. Differential diagnosis from food poisoning should be made very carefully (**Table 17.4**). In case of doubt all steps for cholera should be promptly taken.

The symptoms of cholera are compared below with those of bacterial food poisoning.

LABORATORY DIAGNOSIS⁵

- Culturing *V. cholerae* O-group 1 organisms from feces or vomitus on Peptone Water Tellurite (PWT) medium and subculturing after 4 to 6 hours on Bile Salt Agar (BSA) medium.
- Visualizing characteristic motility of the organisms by dark field or phase microscopy, the motility being inhibited by specific antiserum.

TABLE 17.4: Differentiating features of cholera and food poisoning

Symptoms	Cholera	Food poisoning
• Nausea, retching and pain in stomach	Rare	Common
• Vomiting	Watery, follows diarrhea	Contains food, precedes diarrhea
• Diarrhea	Rice water stools	Fecal matter with offensive smell
• Pain and griping	Absent	Present
• Muscular	Common	Rare
• Urine	Often suppressed	No urinary suppression
• Collapse	Common	Rare
• Fever	Rare	37.2° to 37.8°C
• Headache	Rare	Common
• Toxemia	Marked	Less
• History of common meal	Rare	Common

- Demonstrating significant rise in antibodies (provided vaccine has not been given). These may be antitoxic antibodies or agglutinating or vibriocidal antibodies.
- Biochemical tests by subculturing on separate broths containing mannose, sucrose and arabinose and on peptone water (pH 7.2) show production of acid in the first two sugars and cholera red reaction in peptone water.

MEASURES OF PREVENTION AND CONTROL

Verification

This needs to be done quickly by identification of vibrios in stool.

Notification

Prompt reporting of any case of diarrhea and vomiting suspected to be cholera to health authorities is compulsory. No other communicable disease needs greater stress on this point than cholera. Once an area has been identified as having cholera, reports need to be sent daily and weekly till the area is declared free of cholera. An area is declared free of cholera when 10 days have elapsed since death, recovery or isolation of the last case.¹⁰

Isolation

It should be done to the extent possible in the house, hospital, mobile hospital or isolation camp, both for providing better treatment to the case and for preventing spread of the disease. Isolation is of questionable importance when there are plenty of carriers in the community.

Quarantine

It is no longer recommended.⁵

Diagnosis

It should be based on clinical and epidemiological findings so that institution of anticholera measures is not delayed. It may be confirmed by laboratory tests. However, it should be clearly understood that successful treatment of cholera does not depend in any way on the results of laboratory examinations.¹¹

Different Definitions in Relation to Diarrhea

Dehydration: Means loss of water and dissolved salts from the body, occurring, for instance, as a result of diarrhea.

Rehydration: This means correction of dehydration.

Oral Rehydration Therapy (ORT): The administration of fluid by mouth to prevent or treat the dehydration that is a consequence of diarrhea is known as ORT.

Oral Rehydration Salt (ORS) Solution: It refers specifically to the complete, new WHO/UNICEF formula.

Treatment¹¹⁻¹³

The mainstay of treatment of cholera is rehydration to replace the fluid loss. The concept and strategy of oral rehydration, has revolutionized the management of cholera and has minimized the need for intravenous rehydration. Drug therapy is much less important than rehydration. Rehydration therapy will be discussed under three headings: Principles of rehydration, ORT and IV fluids.

Principles of rehydration: The main principle of fluid therapy is that the output of water and electrolytes from the body in stools, vomit, urine, sweat, and insensible losses should be matched by the input of water and electrolytes. The fluids administered to a dehydrated patient should meet the following three essential needs:

- Correction of the existing water and electrolyte deficit as indicated by the presence of signs of dehydration (rehydration therapy).
- Replacement of ongoing abnormal losses of water and electrolytes due to continuing diarrhea, so as to prevent recurrence of dehydration (maintenance therapy).
- Provision of normal daily requirements during rehydration and maintenance therapy.

Rehydration therapy can usually be achieved orally with oral rehydration salt solution (ORS solution) except in cases with severe dehydration, uncontrollable vomiting, or other serious complications necessitating intravenous therapy. ORS solution is also the fluid used for maintenance therapy. However, normal daily fluid requirements must be given as fluids of lower salt concentration such as plain water, breast milk and diluted milk feeds. This is particularly important in infants who require two times more water per kg than

adults because of their relatively larger surface area and higher metabolic rate.

ORT (Oral Rehydration Therapy) has been hailed as the most important development during recent decades in the field of health. It is estimated that ORT can save most of the more than 4 million young children dying each year in the world from dehydration due to various types of diarrhea.¹⁴

ORT when given along with advice on proper feeding practices has been found to contribute better weight gain and reduce the ill effects of diarrhea on nutritional status.¹⁵ ORT should begin at home with the use of “home available fluids” or a home-prepared “sugar and salt” solution given early during the diarrhea episode to prevent dehydration. Once dehydration sets in, ORT should be provided in the form of standard mixture of glucose and salts (Oral Rehydration Salt).

Oral Rehydration Salts (ORS), first used in 1969 is the nonproprietary name for a balanced glucose-electrolyte mixture, approved and distributed by UNICEF and WHO as a drug for the treatment of clinical dehydration throughout the world.

The contents of the ORS (Oral Rehydration Salts) solution approximate the water and electrolyte composition of diarrheal stool which is isotonic in nature. The standard ORS composition is as follows:

Sodium chloride	3.5 g
Sodium bicarbonate	2.5 g
Potassium chloride	1.5 g
Glucose	20 g
Water	1 liter

The electrolyte content of the ORS¹² is shown in **Table 17.5** along with that of cholera stools in adults and children. It may be mentioned that the sodium content of diarrheal stools is less in infants than in older children, but ORS can be safely given to them. The physiological basis of ORS lies in the fact that the absorption of salt across the intestinal mucosa is greatly increased if it is given with 2 percent glucose solution. The discovery that sodium transport and glucose transport are coupled in the small intestine so that glucose accelerates absorption of solute and water was potentially the most important medical advance of this century.¹⁶ If glucose is not available, double the quantity of sucrose can be used, since the molecular weight of sucrose is twice that of glucose. Potassium chloride is given to correct the potassium loss associated with all acute diarrheas while sodium bicarbonate is given to

correct the acidosis caused by base deficit. However, if these two salts are not present, it is better to start the rehydration therapy by a plain salt sugar solution, to be replaced by the standard ORS as soon as available. Similarly, if a sugar salt solution is not available, it is preferable to start treatment with rice water, barley water, etc. than to withhold fluids altogether. ORS can be started later as soon as possible. The difficulty with fluids like water is that their electrolyte content may be very low.¹²

Locally packed ORS has short shelf life in hot, humid climates. Sodium bicarbonate reacts with glucose in the presence of dampness and the powder becomes discolored and less effective. Replacement of sodium bicarbonate (2.5 g) by trisodium citrate (2.9 g) makes the ORS more stable and also reduces stool output, probably due to the direct effect of trisodium citrate in increasing the intestinal absorption of sodium and water. The WHO and UNICEF recommended the use of ORS-citrate, but it is stressed that there is no need to hesitate to use the ORS-bicarbonate in 1984.¹⁷

After that period, numerous studies have been undertaken to develop an **“improved” ORS** that would be safe and effective as standard ORS for preventing or treating dehydration from all types of diarrhea and in addition, would reduce stool output or have other important clinical benefits. One approach was to reduce the osmolarity of ORS solution to avoid possible adverse effects of hypertonicity on net fluid absorption. This was done by reducing the solution’s glucose and salt (NaCl) concentrations. That would be safe in children with acute noncholera diarrhea, and in adults and children with cholera. Efficacy of ORS solution for treatment of children with acute noncholera diarrhea is improved by reducing its sodium concentration to 75 mEq/l, its glucose concentration to 75 mmol/l, and its total osmolarity to 245 mOsm/l. The need for unscheduled supplemental IV therapy in children given this solution was reduced by 33 percent. With reduced ORS solutions stool output and vomiting was reduced by about 20 and 30 percent respectively. The 245 mOsm/l solution also appeared to be as safe and as effective as standard ORS for use in both children and adults with cholera. The only drawback with low osmolarity ORS being increased incidence of transient, asymptomatic hyponatraemia. Because of the improved effectiveness WHO and UNICEF now recommend reduced osmolarity ORS solution for diarrhea of all etiologies and in all age groups, with the following formulation with a total osmolarity of 245 mOsm/l instead of previously used 311 mOsm/l.¹⁸

Intravenous rehydration: This has to be resorted to when dehydration is severe. It is important to use the correct type of intravenous fluid.⁸ A number of solutions are available for IV infusion. However, some

TABLE 17.5: Electrolyte content (mEq/L) of ORS and cholera stools¹²

	Na	K	Cl	Bicarbonate
ORS	90	20	80	30
Cholera stools				
Adults	135	15	110	40
Children	115.4	40.5	86.5	21.3

do not contain appropriate or adequate amount of the electrolytes required to correct the deficit associated with acute diarrhea. A brief discussion of the intravenous solutions and the guidelines for their administration are given in the next few pages under the National DDC program.

Practical considerations in IV rehydration:

Intravenous therapy can be given into any convenient vein. The most accessible veins are generally those in front of the elbow, on the back of the hand, at the ankle, or, in infants, on the side of the scalp. Use of neck veins or incision to locate a vein are usually not necessary and should be avoided if possible. In cases requiring rapid resuscitation, a needle may be introduced into the femoral vein where it must be held firmly in place and removed as soon as possible. In some cases of severe dehydration, particularly in adults, infusion into two veins may be necessary; one infusion can be removed once rehydration is well in progress. It is useful to mark intravenous fluid bottles at various levels with the time at which the fluid should have fallen to the particular level. This allows easier monitoring of the rate of administration.

Antibiotics and other antidiarrheal agents are not indicated in a routine case of diarrhea. If cholera is present or is suspected, tetracycline should be given. If other specific pathogens are responsible, other specific therapy should be instituted as given in **Table 17.6**. In severe cholera cases, antibiotics have been shown to reduce the volume and duration of diarrhea, the requirements for fluid replacement, and the period of vibrio excretion.

Many other drugs are often prescribed for diarrhea patients. These are of two types. Adsorbents (e.g. Kaolin, pectin, activated charcoal, bismuth subcarbonate) have not been shown to be of value in the treatment of acute diarrhea. Opiatet and opiate derivatives (e.g. tincture of opium, camphorated tincture of opium or paregoric, codeine, diphenoxylate with atropine) may provide some transient pain relief but they markedly decrease intestinal peristalsis and thus delay the elimination of the causative organisms. They can be very dangerous (even fatal) if used in infants.²

Disinfection

Both concurrent and terminal disinfections are important in respect of cholera. This can be done by the following measures:

- Mix with cholera stools and vomit an equal quantity of 5 percent lysotol of 5 percent cresol or 30 percent bleaching powder. Allow to stand for 2 hours and bury the mixture.
- If stools and vomit fall on the floor, the area around the patient should be covered with a thin layer of lime or bleaching power.

TABLE 17.6: Composition of new ORS formulation

New ORS	grams/liter	New ORS	mmol/liter
Sodium chloride	2.6	Sodium	75
Glucose, anhydrous	13.5	Chloride	65
Potassium chloride	1.5	Glucose, anhydrous	75
Trisodium citrate, dehydrate	2.9	Potassium	20
		Citrate	10
Total	20.5	Total Osmolarity	245

- A practical and cheap method is to immerse the pans and receptacles containing vomit and stools in boiling water.
- Immerse the soiled clothes in boiling water or in 2 percent lysotol for some time.
- Whitewash the walls and floors with lime or throw boiling water on them. Mud floors may be burnt with cowdung cakes.
- Boil the utensils and burn cheap fomites.
- Cots and linen may be disinfected by 10 percent formalin, 5 percent lysotol spray or exposure to sun. Steam disinfection may also be done.
- Wash hands with soap and water. Dipping hands in 1 percent lysotol is also useful.
- Well or tank water should be disinfected with bleaching powder so as to get 1.5 to 2.0 ppm of chlorine. This should be the first step when a report is received about occurrence of cholera. Potassium permanganate should not be relied upon.

Antifly Measures

Kill flies and prevent their breeding. Dispose of refuse and other wastes properly. Keep all foods covered. Hospital wards and homes, especially the kitchen, should be fly proof. However, it may be clarified that flies play a comparatively insignificant role in the spread of cholera.

Immunization

Vaccines for cholera are available as:

Injectable killed whole cell vaccine: The injectable killed whole cell vaccine has been found to have a poor efficacy (45%) and the protection lasts for duration of only 3 months. Two doses of the vaccine are administered one week to one month apart. WHO does not recommend the use of the old parenteral vaccine because of its limited protective efficacy and lack of suitability for public health purposes.

Oral cholera vaccine: Among the oral cholera vaccines, Dukoral (WC/rBS) consists of 1 mg of recombinant cholera toxin B subunit plus 2.5×10^{10} of the following *V. cholerae* O1 organisms: formalin-killed El Tor Inaba (Phil 6973); heat-killed classical Inaba (Cairo 48); heatkilled classical Ogawa (Cairo 50); and formalin-killed classical Ogawa (Cairo 50). It

is approved for use in persons aged over two years. Dukoral (WC/rBS) is administered in 3 separate doses, 1 to 6 weeks apart for 2 to 6 years old children and as 2 separate doses, 1 to 6 weeks apart for those aged over 6 years. It confers 85 to 90 percent protection for 6 months among all age groups. The protection declines rapidly after 6 months in young children but remains at about 60 percent after 2 years in older children and adults. The only licensed single-dose live attenuated OCV CVD 103-HgR (Orochol) is no longer available in the market.

The two currently available oral cholera vaccines are not recommended for routine adult immunization. Oral cholera vaccines are not recommended for outbreak control or for prevention of outbreak during emergencies.¹⁹

Health Education and Personal Protection

The community should be informed about the nature of the disease, the mode of spread and the type of safety measures needed for protection. The latter essentially include elementary personal hygiene. Proper washing of hands after defecation with soap or ash should be stressed.¹¹ Provision of safe drinking water and facilities for excreta disposal using low cost techniques²⁰ will go a long way in the control of diarrheal diseases, including cholera.

Surveillance

Surveillance of cholera and other diarrheal diseases and enteric infections is an essential prerequisite for any well planned public health action. This would need the development of the diagnostic facilities, treatment centers, field teams, sanitation, food and water control and health education activities. This is of paramount importance in the endemic areas.

Diarrhea (ICD-A0.9)

In developing countries with poor environmental sanitation, a large number of cases of acute diarrhea in infants and children keep on occurring and may prove fatal. 276 surveys in 60 countries using standard WHO methodology revealed the incidence of diarrhea to be 2.4 to 4.9 episodes per child per year.²¹ Eleven surveys conducted in India revealed an incidence of 1.5–4.5 episodes per child per year.²² The infection occurs through water and food contaminated with bacteria such as *E. coli*, *Shigella* and *Salmonella*. The pathogenic *Escherichia coli* are of three types.¹³

- Invasive *E. coli* (causing primarily colonic disease resembling shigellosis).
- Enterotoxigenic *E. coli* (producing a toxin like *V. cholerae* and presenting profuse watery diarrhea).

- The “classical” enteropathogenic serotypes (causing acute diarrhea, especially in nurseries for the newborns. Though these serotypes may produce enterotoxins, the pathogenic mechanism of diarrhea is not well understood).

Some diarrheas may be protozoal or parasitic in origin. When a bacterial, protozoal or helminthic pathogen is not found, the causative agent of diarrhea may be a virus. The most important among viruses is probably the rotavirus, which is responsible for 25 to 50 percent cases of early childhood diarrhea. In fact, more than 90 percent children have antibodies against rotavirus by the age of 5 years. Other viruses that may be responsible for diarrhea are the Norwalk agent, astrovirus and calcivirus.

Good nutrition, particularly in infants and young children, plays an important role in reducing morbidity and mortality due to diarrheas of infectious origin. The management of diarrheal dehydration by ORS has been already described.

CONTROL OF DIARRHEAL DISEASES

Acute diarrheal diseases are one of the leading causes of childhood mortality and morbidity in the developing countries and a major contributor to malnutrition. Such repeated attacks of diarrhea lead to malnutrition and growth retardation because of associated food restriction by mothers, anorexia, and malabsorption. A number of other studies have shown acute diarrheal diseases to be more common and more severe in undernourished infants and young children (**Table 17.7**).

Realization of the shortcomings of the specific cholera control measures and of the similarities in the epidemiology, pathophysiology, treatment and control of cholera and other acute diarrheas led the WHO to conclude that the development and implementation of national programmes for diarrheal diseases control constituted the best way to prevent and control cholera. In keeping with this, the strategy of National Cholera Control Program was radically changed during the year 1980–81. It was renamed as the Diarrheal Diseases Control Program. The objective was to reduce morbidity and mortality due to diarrheal diseases.²³ Later it took the shape of National Oral Rehydration Therapy Program launched in 1985–86, with focus on better case management through oral rehydration therapy. In 1992–93, the ORT Program became part of the CSSM program. Since 1997, the CSSM program, along with its various components, has been merged into the RCH program. Thus there is no separate national program for control of diarrheal diseases at present. The RCH program is managed by the Department of Family Welfare.

TABLE 17.7: Drugs used in treatment of acute diarrhea due to specific causes¹³

Cause	Drug(s) of choice ¹	Alternative ¹
Severe cholera ²	<i>Tetracycline</i> Children (over 8 yrs) 50 mg/kg/day in 4 divided doses × 2 days Adults-500 mg 4 times a day × 3 days	<i>Furazolidone</i> Children-5 mg/kg/day in 4 divided doses × 3 days Adult-100 mg 4 times a day × 3 days <i>Trimethoprim (TMP)</i> <i>Sulfamethoxazole (SMX)</i> All ages TMP 8 mg/kg/day and SMX 40 mg/kg/day and SMX 40 mg/kg/day in 2 divided doses × 3 days
Shigella dysentery ^{2,3}	<i>Trimethoprim (TMP)</i> <i>Sulfamethoxazole (SMX)</i> Children TMP 10 mg/kg/day and SMX 50 mg/kg/day in 2 divided doses × 5 days Adult TMP 160 mg and SMX 800 mg twice daily × 5 days or <i>Nalidixic acid</i> (should be reserved for severe cases and cases not responding to other drugs) Children 55 mg/kg/day in 4 divided doses × 5 days Adult 1 gm 3 times a day × 5 days	<i>Furazolidone</i> Children-5 mg/kg/day in 4 divided doses × 5 days Adult-100 mg 4 times daily × 5 days Ampicillin-100 mg/kg/day in 4 divided doses × 5 days
Acute intestinal amoebiasis ⁴	<i>Metronidazole</i> ⁵ Children-30 mg/kg/day × 5-10 days Adults-800 mg 3 times a day × 5-10 days	<i>Tinidazole</i> Children-0.5-1 g daily × 2-3 days (50 mg/kg) Adult-2 g daily × 3 days
Acute giardiasis ⁴	<i>Metronidazole</i> Children-15 mg/kg/day × 5 days Adult-200 mg 3 times a day × 5 days	<i>Tinidazole</i> Children-0.5-1 g single dose (50 mg/kg) Adult-2 g single dose

- All doses given are for oral administration unless otherwise indicated. If drugs are not available in liquid form for use in young children, it may be necessary to approximate the doses given in **Table 17.7**.
- Selection of antibiotic for treatment should take into account frequency of resistance to antibiotics in the area.
- Antibiotic therapy not essential for successful therapy but shortens duration of illness and excretion of organisms in severe cases.
- Antibiotic therapy especially required in infants with high fever or severe undernutrition.
- Requires microscopic examination of stool for diagnosis.
- Tinidazole and ornidazole can also be used.

RATIONALE

Diarrheal diseases are a major cause of morbidity and mortality among children under five years (0 to 5 years). It has been estimated that diarrhoea accounts for 28 percent of deaths in this age group, i.e. 1 million deaths every year. Most of the deaths in diarrhoea are due to dehydration (loss of water and electrolytes) caused due to frequent passage of loose watery motions. A child, on an average, suffers from 2 to 3 attacks of diarrhea each year. Prevention of diarrhea itself is not an easy task and remains a long-term goal to be achieved. The program, therefore, presently aims at reducing deaths due to diarrheal diseases among the 0 to 5 years age group.

GOAL

To reduce deaths due to dehydration caused by diarrhoeal disease through promotion of Oral Rehydration Therapy (ORT) by 30 percent in 1995 and by 70 percent in the year 2000.

COVERAGE

- Correct case management at home and all health facilities.
- Improve ORT use rate to 60 percent.

Identification Guidelines

What is Diarrhea?

Diarrhea is defined as passage of liquid or watery stools. These liquefied stools are usually passed more than three times in a day; however, it is the recent change in consistency and character of the stools rather than the number of stools that is the more important feature. Passage of even one large watery motion among children may constitute diarrhea. When stools contain mucus or blood it is known as dysentery.

What is not Diarrhea?

- Passage of frequent formed stools.
- Passage of pasty stools in a breastfed child.
- Passage of stools during or immediately after feeding.

- Passage of frequent loose greenish yellow stool in the 3rd and 4th day of life (Transitional diarrhea). In most situations, mothers know better what is an abnormal stool of her child.
- Ensure availability of ORS packets through government outlets and in villages through village level functionaries including Anganwadi Workers (AWW) wherever possible.
- Eliminate irrational use of drugs in the management of diarrheal diseases.

Three Types of Diarrhea

1. *Acute watery diarrhea* starts suddenly and may continue for a number of days but not more than 14 days. Most of these are self limiting and will last for 3 to 7 days.
2. *Dysentery is diarrhea* with visible blood in stools.
3. *Persistent diarrhea* begins acutely but is of unusually long duration, i.e. lasting more than 14 days.

Why Diarrhea is Dangerous?

- Diarrhea leads to loss of water and electrolytes. If untreated, dehydration leads to death.
- Diarrhea leads to undernutrition because—(i) nutrients are lost from the body, (ii) a child with diarrhea may be anorexic, and (iii) mothers often reduce food for some more days even after diarrhea is treated or has stopped.

STRATEGY

- Correct case management at all levels enabling mothers at home to use home available fluids (HAF) for diarrhea without dehydration followed by Oral Rehydration Salts (ORS) solution whenever a child gets dehydration. Two things will have to be ensured for this (i) Mothers should be able to recognize dehydration so that they can start Oral Rehydration Therapy (ORT) and can seek help when the condition of the child worsens, (ii) Correct and improved management of cases depending on degree of dehydration at all health facilities.

The strategy is based on the following observations:

- Ninety percent of all diarrheal episodes do not develop dehydration. These can be managed at home by mothers with the use of home available fluids (HAF) and continued feeding.
- Nine percent of all episodes will develop some dehydration. These need to be managed at health facilities with the use of ORS solution.
- One percent of episodes will develop severe dehydration needing intravenous infusion therapy. These need to be referred to the nearest facility where intravenous infusion could be given.

ASSESSMENT OF A CHILD WITH DIARRHEA

A child with diarrhea should be assessed to determine the nature and pattern of diarrhea, the degree of dehydration (No signs, some or severe dehydration) and the presence of any other problems (i.e. Blood in stool or severe undernutrition) so that appropriate treatment can be started without delay.

History should be taken from the patient or a family member. ASK questions to obtain information on: Duration of diarrhea, consistency of stool, presence of blood in stool, presence of fever, convulsions or other problems, preillness feeding practices, type and quantity of fluids (Including breast milk), food consumed during illness and drugs or other remedies taken. However, answers to many of these questions will not decide the degree of dehydration. Degree of dehydration will be determined by the signs as described in **Table 17.8**.

TABLE 17.8: Look, feel, decide chart for assessment of dehydration in diarrhea

	A	B	C
• <i>Look:</i> Condition	Well, alert	Restless, irritable	Lethargic or unconscious; floppy
Eyes	Normal	Sunken	Very sunken and dry
Tears	Present	Absent	Absent
Mouth and Tongue	Moist	Dry	Very dry
Thirst	Drinks normally, not thirsty	Thirsty, drinks eagerly	Drinks poorly or not able to drink
• <i>Feel:</i> Skin Pinch	Goes back quickly	Goes back slowly	Goes back very slowly
• <i>Decide:</i>	The patient has <i>no signs of dehydration</i>	If the patient has two or more signs, including at least one sign, there <i>is some dehydration</i>	If the patient has two or more signs, including at least one sign, there is <i>severe dehydration</i>
• <i>Treat:</i>	Use Treatment Plan A	Weigh the patient, if possible and use Treatment Plan B	Weigh the patient and use Treatment Plan C <i>urgently</i>

Physical Examination

Look at the patient: (i) General condition: Alert; restless or irritable, floppy, lethargic or unconscious, severely undernourished? (ii) Are the eyes: Sunken or very sunken and dry? (iii) Are there tears when the child cries? Are the mouth and tongue: Moist, dry or very dry? (Confirm by feeling the child's tongue and the inside of the mouth with a clean dry finger), (iv) When water is offered to drink: Is it taken normally or is the patient unable to drink?

Feel skin pinch: (Skin turgor). When the skin over the abdomen or the thigh is pinched and released, does it flatten: Quickly, slowly or very slowly?

Take temperature: Does the child have a high fever (Axillary temperature more than 38.5° C or 101°F).

MANAGEMENT OF A CHILD WITH ACUTE DIARRHEA

Once assessment of degree of dehydration is performed, the appropriate treatment plan has to be selected (**Table 17.9**).

It is extremely important to prevent nutritional damage by feeding during and after diarrhea.

WHEN THERE ARE NO SIGNS OF DEHYDRATION (TREATMENT PLAN A)

This aims at preventing dehydration in early diarrhea. Mothers should be taught how to prevent dehydration at home by giving the child increased amount of fluids, how to continue to feed the child and why these actions are important. There are three rules for treating diarrhea at home. See Treatment Plan A (**Table 17.10**).

Rule 1 (*Give the child more fluids than usual to prevent dehydration*): Home made or Home available fluids which are traditionally acceptable can be used for home therapy of diarrhea. Traditional fluids may vary from place to place. Home available fluids (HAF) such as rice water, dal water, sikanji, buttermilk, etc. can be promoted depending on suitability, availability and acceptability at local levels.

Rule 2 (*Continue feeding the child*): Food should never be withheld during diarrhea. This is important as it prevents undernutrition of the child. Breastfeeding should continue without interruption. The aim is to give as much nutrient rich food as the child will accept. Child should be given additional meals after the episode of diarrhea is over for some days to prevent undernutrition.

Rule 3 (*Watch for signs of dehydration*): Explain to the mother that she should take her child to a health worker if the child does not get better in two days or child starts passing many stools, has repeated vomiting, is eating and drinking poorly, develops excessive thirst, develops fever or has blood in stools. When a parent brings a child with diarrhea but no dehydration give one ORS packet.

WHEN THERE IS SOME DEHYDRATION (TREATMENT PLAN B)

Oral rehydration solution (ORS) must be used in cases with some dehydration. Treatment with ORS aims at: Correction of water and electrolyte deficit (Rehydration) (i) As indicated by degree of dehydration (ii) Replacement of ongoing losses due to continuing diarrhea (maintenance) and (iii) Provision of normal daily fluid requirement.

The detailed composition of ORS (WHO formulation) is:

The ORS formula given above is the one currently recommended by WHO and UNICEF. If trisodium citrate dihydrate is not available, sodium citrate can be used in an equal amount. The earlier formula recommended by WHO though still in use, has 2.5 g sodium bicarbonate in place of 2.9 g citrate. The citrate formula has the following advantages over the bicarbonate formula:

- It is more stable
- Stool output is lesser, especially in high output diarrhea of cholera. This may be attributable to the direct effect of trisodium citrate upon intestinal water and sodium absorption.

It is very important that the ORS solution is mixed properly. Packets that contain the ingredients as stated above are made for mixing in one liter of drinking water. Preparation of ORS solution is a skill that all health workers should have. They must always try to supply ORS solution as mothers can commit serious mistakes in preparing the solution.

TO PREPARE ORS SOLUTION

- Wash your hands.
- Measure 1 liter of clean drinking water using the measuring container.
- Pour all the powder from one packet into the water and mix well until powder is completely dissolved.

Fresh ORS solution should be mixed each day in a clean container. The container should be kept covered. Any solution remaining from the day before should be thrown away then and there.

For determining the approximate volume of ORS solution to be given at different ages (when it is not possible to weigh the child)—the Table given under treatment Plan B (**Table 17.11**) may be used as a guideline. The exact quantity of ORS solution to be given will however, depend upon the child's

TABLE 17.9: Treatment plan A to C

For no dehydration	Treatment Plan A (Prevention of dehydration)
For some dehydration	Treatment Plan B (Rehydration with ORS solution)
For severe dehydration	Treatment Plan C (Rehydration with IV infusion)

TABLE 17.10: Treatment plan A for diarrhea without dehydration²⁴

Use this plan to teach the mother to:

- Continue to treat at home her child's current episode of diarrhea.
- Give early treatment for future episodes of diarrhea.

Explain the three rules for treating diarrhea at home:

1. Give the child more fluids than usual to prevent dehydration:
 - Use a recommended home fluid, such as a cereal gruel. If this is not possible, give plain water. Use ORS solution for children described below.
 - Give as much of these fluids as the child will take. Use the amounts shown below for ORS as a guide.
 - Continue giving these fluids until the diarrhea stops.
2. Give the child plenty of food to prevent undernutrition:
 - Continue to breastfeed frequently
 - If the child is not breastfed, give the usual milk. If the child is less than 6 months old and not yet taking solid food, dilute milk or formula with an equal amount of water for 2 days.
 - If the child is 6 months or older, or already taking solid food:
 - Also give cereal or another starchy food mixed, if possible, with pulses, vegetables, and meat or fish. Add 1 or 2 teaspoonfuls of vegetable oil to each serving.
 - Give fresh fruit juice or mashed banana to provide potassium.
 - Give freshly prepared foods. Cook and mash or grind food well.
 - Encourage the child to eat; offer food at least 6 times a day.
 - Give the same foods after diarrhea stops, and give an extra meal each day for two weeks.
3. Take the child to the health worker if the child does not get better in 2 days or develops any of the following:
 - Many watery stools
 - Repeated vomiting
 - Marked thirst
 - Eating or drinking poorly
 - Fever
 - Blood in the stool.

Children should be given ORS solution at home, if:

- They have been on treatment plan B or C.
- They cannot return to the health worker if the diarrhea gets worse.
- It is national policy to give ORS to all children who see a health worker for diarrhea.

If the child will be given ORS solution at home, show the mother how much ORS to give after each loose stool and give her enough packets for 2 days:

Age	Amount of ORS to give after each loose stool	Amount of ORS to provide for use at home
Less than 24 months	50-100 ml	500 ml/day
2 up to 10 years	100-200 ml	1000 ml/day
10 years or more	As much as wanted	2000 ml/day

Describe and Show the Amount to be Given after each Stool Using a Local Measure.

Show the Mother How to Mix ORS

Show Her How to Give ORS:

- Give a teaspoonful every 1-2 minutes for a child under 2 years.
- Give frequent sips from a cup for an older child.
- If the child vomits, wait 10 minutes. Then give the solution more slowly (For example, a spoonful every 2-3 minutes).
- If diarrhea continues after the ORS packets are used up, tell the mother to give other fluids as described in the first rule above or return for more ORS.

dehydration status. Patients with many or more marked signs of dehydration will require more solution than those with fewer or less marked signs. If the patient wants more ORS solution than the volume shown on the chart and there are no signs of overhydration, give more.

WHEN THERE IS SEVERE DEHYDRATION (TREATMENT PLAN C)

Treatment Plan C deals with treatment of severe dehydration. Community based health staff should be advised not to attempt IV treatment in these cases. They should, however, start immediate treatment with ORS as per Treatment Plan B and at once refer the case to the

nearby facility for IV treatment. If ORS packet is not available, treatment with 'Home Available Fluids' should be started.

INTRAVENOUS THERAPY FOR SEVERE DEHYDRATION

Solutions for Intravenous Infusion

A number of solutions are available for IV infusion; however, some do not contain appropriate or adequate amounts of the electrolytes required to correct the deficits found in dehydration associated with acute diarrhea.

The preferred solution is *Ringer's Lactate Solution* which supplies adequate concentration of sodium and

TABLE 17.11: Treatment plan B for diarrhea with some dehydration²⁴

Approximate amount of ORS solution to give in the first 4 hours:						
Age*	Less than 4 months	4-11 months	12-23 months	2-4 years	5-14 years	15 years of older
Weight in ml	Less than 5 kg	5-7.9 kg	8-10.9 kg	11-15.9 kg	16-29.9 kg	30 kg or more
in local measure	200-400	400-600	600-800	800-1200	1200-2200	2200-2400

*Use the patient's age only when you do not know the weight. The approximate amount of ORS required (in ml) can also be calculated by multiplying the patient's weight (in grams) times 0.075.

- If the child wants more ORS than shown, give more.
- Encourage the mother to continue breastfeeding.
- For infants under 6 months who are not breastfed, also give 100-200 ml clean water during this period.

Observe the child carefully and help the mother give ORS solution:

- Show her how much solution to give her child.
- Show her how to give it—a teaspoonful every 1-2 minutes for a child under 2 years, frequent sips from a cup for an older child.
- Check from time to time to see if there are problems.
- If the child vomits, wait 10 minutes and then continue giving ORS, but more slowly, for example, a spoonful every 2-3 minutes.
- If the child's eyelids become puffy, stop ORS and give plain water or breast milk. Give ORS according to Plan A when the puffiness is gone.

After 4 hours, reassess the child using the assessment chart. Then select plan A, B or C to continue treatment:

- If there are no signs of dehydration shift to Plan A. When dehydration has been corrected, the child usually passes urine and may also be tired and fall asleep.
- If signs indicating some dehydration are still present, repeat Plan B, but start to offer food, milk and juice as described in Plan A.
- If signs indicating severe dehydration have appeared, shift to Plan C.

If the mother must leave before completing treatment plan B:

- Show her how much ORS to give to finish the 4-hour treatment at home.
- Give her enough ORS packets to complete rehydration, and for 2 more days as shown in Plan A.
- Show her how to prepare ORS solution.
- Explain to her the three rules in Plan A for treating her child at home:
 - To give ORS or other fluids until diarrhea stops.
 - To feed the child.
 - To bring the child back to the health worker, if necessary.

potassium and the lactate yields bicarbonate for correction of acidosis. An acceptable solution is normal saline which is readily available. It will not correct the acidosis and will not replace potassium losses. If used, this solution should be accompanied by ORS solution orally.

Providing IV therapy for severe dehydration: The purpose is to give the patient a large quantity of fluids quickly to replace the very large fluid loss which has resulted in severe dehydration.

Plain glucose dextrose solutions should not be used as they provide only water and sugar. They do not contain electrolytes and thus they do not correct the electrolyte losses causing the acidosis.

Begin intravenous therapy quickly in the amount specified in Treatment Plan C (**Table 17.12**).

- Start IV fluids immediately. If the patient can drink, give ORS by mouth while the drip is set up. Give 100 ml/kg Ringer's Lactate solution (or, if not available, Dextrose saline).
- Repeat once if radial pulse is still very weak or not detectable.
- Reassess the child every 1 to 2 hours. If hydration is not improving, give the IV drip more rapidly.
- Also give ORS (about 5 ml/kg/hour) as soon as the patient can drink: Usually after 3 to 4 hours (infants) or 1 to 2 hours (older patients).

- After 6 hours (infants) or 3 hours (older patients), evaluate the patient using the assessment chart. Then choose the appropriate Plan (A, B or C) to continue treatment.

POLICY ON USE OF ZINC IN THE NATIONAL PROGRAM FOR MANAGEMENT OF DIARRHEA

Zinc is a very safe drug and the window between therapeutic and toxic dose of zinc is large. A stable formulation (stable at room temperature for 3 years) is available and is well accepted by children and mothers without any side effects. Zinc (20 mg/day for 14 days) is to be used in the national program as an adjunct to ORS in the management of diarrhea in children older than 2 months.

Recommendations

20 mg zinc sulfate dispersible tablet is to be used in childhood diarrhea. Children aged 2 to 6 months to be advised 1/2 tablet per day dissolved in breast milk. Those older children aged more than 6 months will be advised 1 tablet a day dissolved in breast milk or water. The duration of therapy will be 14 days beginning from the day the child sought care. But zinc fortified ORS is not recommended, since zinc intake would not be

TABLE 17.12: Treatment plan C for diarrhea with severe dehydration²⁴

Follow the arrows. If answer is "Yes", go across. If "No", go down

Start here

Can you give intravenous (IV) fluids immediately?

Yes → Start IV fluids immediately. If the patient can drink, give ORS by mouth while the drip is set up. Give 100 ml/kg Ringer's lactate solution (or, if not available, normal saline), divided as follows:

Age	First give 30 ml/kg in	Then give 70 ml/kg in
Infants (under 12 months)	1 hour*	5 hours
Older	30 minutes*	2½ hours

*Repeat once if radial pulse is still very weak or not detectable.

- Reassess the patient every 1-2 hours. If hydration is not improving, give the IV drip more rapidly.
- Also give ORS (about 5 ml/kg/hour) as soon as the patient can drink: Usually after 3-4 hours (infants) or 1-2 hours (older patients).
- After 6 hours (infants) or 3 hours (older patients), evaluate the patient using the assessment chart. Then choose the appropriate Plan (A, B or C) to continue treatment.

No ↓

Is IV treatment available nearby (Within 30 minutes)?

Yes →

- Send the patient immediately for IV treatment.
- If the patient can drink, provide the mother with ORS solution and show her how to give it during the trip

No ↓

Are you trained to use a nasogastric (NG) tube for rehydration?

Yes →

- Start rehydration by tube with ORS solution. Give 20 ml/kg/hour for 6 hours (total of 120 ml/kg)
- Reassess the patient every 1-2 hours:
 - If there is repeated vomiting or increasing abdominal distension, give the fluid more slowly.
 - If hydration is not improving after 3 hours, send the patient for IV therapy.
- After 6 hours, reassess the patient and choose the appropriate Treatment Plan.

No ↓

Can the patient drink?

Yes →

- Start rehydration by mouth with ORS solution, giving 20 ml/kg/hour for 6 hours (total of 120 ml/kg).
- Reassess the patient every 1-2 hours:
 - If there is repeated vomiting, give the fluid more slowly
 - If hydration is not improving after 3 hours, send the patient for IV therapy
- After 6 hours, reassess the patient and choose the appropriate Treatment Plan.

No ↓

Urgent: Send the patient for IV for NG treatment

Notes:

- If possible, observe the patient at least 6 hours after rehydration to be sure the mother can maintain hydration giving ORS solution by mouth.
- If the patient is above 2 years and there is cholera in your area, give an appropriate oral antibiotic after the patient is alert.

standardized, because of variable amounts of ORS consumed by children.²⁵

Rationality of adding Zinc in Management of Diarrhea

Apart from reducing duration and severity of the treated episodes of acute diarrhea, Zn treatment in programmatic condition has the potential to decrease hospital admission rates by 15 to 20 percent, decrease child mortality by 3 to 5 percent and decrease the incidence of subsequent episodes of diarrhea and possibly pneumonia over ensuing 3 months. Zn addition to ORS for treatment of diarrhea has been shown to substantially reduce use of unwarranted drugs during acute diarrhea. This is likely to help reduce emergence of drug resistant enterobacteria, a major public health problem. The critical issues to enable Zn to be effective are that it must be freely available and accessible round the year in every village and all health personnel, including private practitioners and AWW, must be included in the network of Zn distribution through intersectoral coordination.

To achieve this goals, an effective communication strategy is required. It is recommended that all professional bodies and institutions be engaged to promote the use of zinc along with ORS in treatment of diarrhea.

MANAGEMENT OF A CHILD WITH DYSENTERY

When the child has diarrhea with blood, treat with cotrimoxazole. Give paracetamol for fever. Also give ORS and advise early feeding. Observe the child for two days and proceed as follows:

- Child well or definitely improving (as indicated by disappearance of fever and blood in stools)—Continue treatment and monitor weight response.
- Child not well or improving—Treat with nalidixic acid and monitor weight response.

MANAGEMENT OF A CHILD WITH PERSISTENT DIARRHEA (TABLE 17.13)

- Persistent diarrhea begins as acute diarrhea and continues for more than 14 days.

TABLE 17.13: Managing other problems associated with diarrhea

Ask about blood in the stool	<p><i>If blood is present:</i></p> <ul style="list-style-type: none"> • Treat for 5 days with an oral antibiotic recommended for <i>Shigella</i> in your area—Cotrimoxazole • Teach the mother to feed the child as described in Plan A. • See the child again after 2 days if: <ul style="list-style-type: none"> – Under 1 year of age – Initially dehydrated – There is still blood in the stool – Not getting better. • If the stool is still bloody after 2 days, change to a second oral antibiotic recommended for <i>Shigella</i> in your area. Give it for 5 days—Nalidixic acid
Ask when this episode of diarrhea began	<p><i>If diarrhea has lasted at least 14 days:</i></p> <ul style="list-style-type: none"> • Refer to hospital if: <ul style="list-style-type: none"> – The child is under 6 months old – Dehydration is present (Refer the child after treatment of dehydration) • Otherwise, teach the mother to feed her child as in Plan A, except: <ul style="list-style-type: none"> – Dilute any animal milk with an equal volume of water or replace it with a fermented milk product, such as yoghurt – Assure full energy intake by giving 6 meals a day of thick cereal and added oil, mixed with vegetables, pulses, meat, or fish • Tell the mother to bring the child back after 5 days: <ul style="list-style-type: none"> – If diarrhea has not stopped, refer to hospital – If diarrhea has stopped, tell the mother to: <ol style="list-style-type: none"> i. Use the same foods for the child's regular diet ii. After 1 more week, gradually resume the usual animal milk iii. Give an extra meal each day for at least 1 month.
Look for severe undernutrition	<p><i>If the child has severe undernutrition:</i></p> <ul style="list-style-type: none"> • Do not attempt rehydration: refer to hospital for management. • Provide the mother with ORS solution and show her how to give 5 ml/kg/hr during the trip.
Ask about fever and take temperature	<p><i>If temperature is 39°C or greater:</i></p> <ul style="list-style-type: none"> • Give paracetamol <p><i>If there is Falciparum malaria in the area, and the child has any fever (38° or above) or history of fever in the past 5 days:</i></p> <ul style="list-style-type: none"> • Give an antimalarial (or manage according to your malaria program recommendation)

- Malnutrition in such children is common due to a combination of unresolved infection and malnutrition.
- A vicious cycle between malnutrition and diarrhea, each precipitating the other, leads to chronic illness in the child.
- Refer to child specialist, if the child is under 6 months old, dehydration is present (Refer the child after treatment of dehydration).
- Otherwise, teach the mother to feed her child as in Plan A, except:
 - Dilute any animal milk with an equal volume of water or replace it with a fermented milk product, such as yoghurt.
 - Assure full energy intake by giving 6 meals a day of thick cereal and added oil, mixed with vegetables, pulses, meat, or fish.
- Tell the mother to bring the child back after 5 days:
 - If diarrhea has not stopped, refer to hospital.
 - If diarrhea has stopped, tell the mother to use the same foods for the child's regular diet after 1 more week, gradually resume the usual animal milk. Give an extra meal each day for at least 1 month.

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Food Poisoning

According to the American Public Health Association “food poisoning” (synonymous with food-borne intoxication and food-borne infections) is a generic term applied to illness acquired through consumption of contaminated food or water. The term applies to “intoxications caused by chemical contaminants (heavy metals and others), toxins elaborated by bacterial growth and a variety of noxious organic substances that may be present in natural foods such as certain mushrooms, mussels, eels, scombroid fish and other seafood”. This definition also includes acute *Salmonella* infection.

The term *food poisoning* generally refers to those conditions with short incubation period which occur due to toxins produced by infective agents either *in vitro* or *in vivo*. These include *Staph. aureus*, *Cl. perfringens*, *Vibrio parahemolyticus*, *Cl. botulinum* and *Bacillus aureus*.¹ The diagnosis is generally suggested by epidemiologic findings. Single cases of food poisoning are difficult to identify unless, as in botulism, there is a distinctive clinical syndrome.

Acute gastroenteritis, on the other hand, is an infectious disease caused by several agents, including rotavirus, coronavirus, other enteroviruses, enterotoxigenic *Escherichia coli*, *Salmonella* and *Giardia lamblia*.² The mode of transmission of gastroenteritis is usually by fecal oral route, often through food and sometimes through water. Occasionally, fecal-respiratory route and as yet

unknown routes may also be responsible.¹ In contrast, food poisoning is, as implied by its name, an illness caused by consumption of unwholesome food. However, since *Salmonella gastroenteritis* is often described as *Salmonella* food poisoning, this will also be discussed under this section. It may be mentioned that sometimes the symptoms may be both due to toxic production as well as to infection and proliferation of organisms.³ The etiological classification of food poisoning, along with the clinical and epidemiological features of each type, including the salmonellar type, are given in **Table 17.14**. The distinctive features of cholera and food poisoning have already been given in **Table 17.3**.

Clinical Features

- Abdominal pain
- Vomiting and diarrhea
- With or without fever

Causes of Food Poisoning

Non-bacterial	Bacterial ⁴
1. Mushroom poisoning	1. <i>Salmonella</i>
2. Chemical poisoning	2. <i>Clostridium perfringens</i>
	3. <i>Staphylococcus aureus</i>
	4. <i>Bacillus cereus</i>
	5. <i>Clostridium botulinum</i> (Botulism)

Features of Non-bacterial Food Poisoning

Mushroom poisoning:

Causes: Eating fungi like *Amanita phalloides* instead of edible mushroom or eating sprouting potatoes which contains excess of alkaloid Solanine.

Symptoms: Abdominal pain, vomiting, diarrhea, sweating, miosis, diplopia, muscular incoordination, convulsion, coma.

Antidote: Atropine.

Chemical poisoning:

- Contaminated by fertilizers, pesticides (agricultural / industrial).
- Food contaminated with metallic poisons due to faulty cooking.
- Contamination from storage such as use of cheap enamel dishes or galvanized pans.

Prevention

Proper inspection of slaughter houses, meat markets, hotels, dairies and other food establishments should be enforced as a general community measure. It may be mentioned that the majority of food poisoning cases occur due to contamination of foods of animal origin.

TABLE 17.14: Features of different types of food poisoning

Causative agents	Symptoms	Source of infection	Mode of transmission	Incubation period
<i>Salmonella</i>	Abdominal pain, diarrhea, vomiting, fever	Patients and convalescent carriers; more commonly rodents, infected cattle and other livestock such as cats, dogs, pigs, ducks and turkeys; eggs and egg powdes	Microorganisms multiply in foods, more so in animal foods like milk and milk preparations, meat, fish, eggs, icecream, puddings, pastries sausages, meat pies. Infection may be transmitted through milk and meat of infected animals or the cooked food gets infected by droppings of rodents	12-24 hours up to 5 days
Bacterial intoxication by <i>S. aureus</i> enterotoxins	Salivation, nausea, vomiting, abdominal pain, prostration and subnormal temperature, not fatal	Usually man. <i>S. aureus</i> transiently colonises the nasopharynx of 70-90% persons and resides permanently in 10-30% Nasal carriage often leads to skin colonization as well ⁵	<i>Staph aureus</i> infects the foods, especially milk, ice-cream, custard and jelly during preparation and handling. Organisms multiply and produce an exotoxin called enterotoxin which is heat stable and is not destroyed by boiling. Refrigeration prevents multiplication	1-6 hours (short because the toxin is preformed)
<i>Cl. perfringens</i> type A	Abdominal pain, diarrhea (explosive) without nausea and vomiting. Not fatal	The organism can be easily grown from soil, water, air and animal and human feces	The infection can usually be traced to contamination of food by soil or feces. Microorganisms multiply and produce <i>toxin</i> in the contaminated food	8-12 hours
<i>Cl. botulinum</i> (Botulism)	Change of voice, diplopia, ptosis, cranial nerve palsies, obstinate constipation . Death in 3-7 days, mortality high, up to 40% Death due to cardiac or respiratory failure	Spores from soil and intestinal tract of animal infect the food	Tinned food, if infected, decomposes under anaerobic conditions. Food may be altered physically the <i>exotoxin</i> produced is heat labile, destroyed in half an hour at 80°C	12-36 hours
<i>B. cereus</i>	Vomiting type: Vomiting with nausea, salivation, abdominal pain Diarrheal type: Diarrhea, lower abdominal pain nausea with little vomiting	Contaminated food. The organism is commonly found in soil and in raw, dried and processed foods	Traced to raw, uncooked or partially cooked food and tinned foods	1-6 hours in emetic type, 12-24 hours in diarrheal type
Campylobacter jejuni (most common) <i>C. coli</i> <i>C. Laridis</i>	Vomiting bloody diarrhea, Abdominal pain, fever. Self limiting, non fatal	Poultry, raw milk, raw meat	Traced to poultry, raw milk, known to cause epidemics of food poisoning in nurseries, Pediatric wards and communities in developed countries	3-5 days
Vibrio parahemolyticus	Diarrhea (blood mucus), Vomiting, abdominal pain, fever	Sea food like shell fish, crabs, lobsters	Traced to improperly cooked sea foods	12-18 hours
<i>E. coli</i> 0157–H7 most common	Bloody diarrhea, abdominal pain. Usually self limiting. Some people develop Hemolytic uremic syndrome	Beef, raw milk, raw apple juice	Traced to beef raw milk, raw apple juice	3-4 days

As a measure of individual safety, the following precautions should be observed:

- Foodstuffs should be selected properly and cooked well. The cooked food should be properly stored in refrigerators or hot cases and not exposed to dust, flies or rats.
- Food items should not be left overnight in warm pantries. Not eaten items should be kept immediately in cold storage to prevent bacterial multiplication and toxin production.
- The kitchen should have enough space, light, ventilation and washing facilities. All garbage or waste

food should be kept covered. Rodent and insect control.

- Cooking staff should not be carriers of salmonellae and should not have obvious staphylococcal infection.
- Frequent washing of hands with soap, especially after visit to latrine, should be insisted upon.
- Food should be served hot. It is safer to heat the cold food again before serving. Food with unusual smell should be discarded.

Control

When there is a report of case(s), of food poisoning, the remains of food, empty containers, stools and vomit should be seized and sent immediately in an ice box for bacteriological and chemical examination. Organs removed after postmortem may be sent in 30 percent glycerine solution. It is necessary to trace the source of contamination and to deal with it properly. The containers used for cooking the suspected food should be disinfected and the remaining food should be destroyed.

TRACING THE SOURCE OF INFECTION

- Find the extent of the outbreak, i.e. the total number of persons who took the food and of those who suffered.
- Study the clinical picture of each case. Make a special note of the nature of onset, incubation period and involvement of nervous system, if any.
- Trace the evidence implicating a particular food. Note the time of the last meal and ascertain the persons who developed symptoms or remained symptom free after consuming a particular item of food.
- Confirm the nature of the toxic agent on the basis of chemical, bacteriological and postmortem reports.
- Investigate the source of infection, the means of contamination and the circumstances responsible for the same during storage.
- Assessment of environmental factors: kitchen, dining hall, storage of food grains and cooked food, presence of rodents.
- Record the history of any illness among food handlers and examine their stools, urine and blood for carrier state.
- Laboratory report: Vomitus, stool of patients for culture, sample of suspected food, serological test of blood for antibody titre.
- Draw conclusions and make appropriate recommendations.

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Enteric Fevers

This group includes typhoid and paratyphoid A, B and C. In India typhoid and paratyphoid A only are found.¹

Typhoid (ICD-A01.0)

IDENTIFICATION

Typhoid is a continuous fever lasting 3 to 4 weeks, usually with headache, bronchitis and gastrointestinal symptoms. Onset is slow. In a classical case, the fever rises daily in a **step ladder pattern** during the first week, remains continuously high during the second and third weeks and comes down gradually by the fourth week.

The patient becomes much more ill, appearing exhausted and often prostrated. In early part of the disease, there may be marked **constipation** or '**pea soup**' **diarrhea**, along with marked abdominal distention.

During the early part, physical signs are few. Later, splenomegaly, abdominal distention, tenderness, **relative bradycardia** and occasionally meningismus appear. The rash (**rose spots**), is a pink papule 2 to 3 mm in diameter that fades on pressure is found principally on the trunk which commonly appears during the 2nd week of disease and disappears by 3 to 4 days.

Death may occur in the third week due to perforation or hemorrhage from ulcers in the intestine. High fever, bronchopneumonia or heart failure may also lead to death.

The classical presentation described above is seen only in a minority of patients. Kamat¹ has found continuous fever only in 10 to 15 percent and some authors have described rates as low as 5 percent. The fever is often intermittent or remittent and is often simply irregular. Also, respiratory symptoms are found in one-third to half of the patients. One-fourth cases of enteric fever may, in fact, present with upper respiratory tract infection and the diagnosis may be missed without a blood culture. As many as 45 percent patients of enteric fever have cough and 32 percent have rhonchi.¹

Convalescence is prolonged. Relapse may occur after a week or 10 days of afebrile period, lasting for 10 to 15 days. Blood shows leukopenia. Blood culture during initial 7 to 10 days may reveal the causative

organism. Widal agglutination test showing higher titres of specific antibodies becomes positive later.

Stool culture is positive for the typhoid bacilli from second week onwards and may remain so up to two weeks after convalescence. Urine culture may also be positive during convalescence or even beyond.

COMPLICATIONS

Intestinal hemorrhage or intestinal perforation may occur during the third week of the disease. Pneumonia, urinary retention, myocarditis, cholecystitis, nephritis, osteomyelitis, and meningitis may also be noticed.

History and Prevalence

Enteric fevers occur all over the world but are more common in tropical and subtropical countries. Typhoid is found in endemic form in all big towns and even large villages. Incidence rises in summer. Epidemics may occur when water and milk supplies are contaminated. Since typhoid is not a notifiable disease in India, detailed figures about its occurrence are not available. The morbidity rate varies from 102 to 2219 per 1,00,000 population in different parts of India.² Incidence in Delhi has been estimated at 110 and 75 per 1,00,000 among males and females respectively.³ According to cause specific morbidity and mortality statistics in India, 3,40,484 cases of typhoid occurred in India during 1994, with 382 deaths.⁴ This contrasts with the reported case fatality rate of 10 percent without and less than 1 percent with antibiotic therapy.⁵ Relapse rate is 15 to 20 and 5 to 10 percent respectively in patients who have or have not received antibiotic therapy.⁵ According to all India age specific mortality data, about one fourth typhoid deaths each occur in the age groups 0 to 4 years, 5 to 24 years, 25 to 54 years and 55+ years.⁴

Causative Agent

Typhoid is caused by *Salmonella typhi*. It is readily killed on heating to 60°C for 15 minutes or on boiling. It can survive in ice for considerable time and for some days in fresh or salt water. It can withstand drying, hence dust and dry excreta or soiled clothes also play a part in the spread. It survives very long in oysters and shellfish and can multiply freely in milk and butter without changing their taste or appearance. It can survive in ripened cheese and lives in sewage or sewage contaminated water for sufficient time.

106 types of *S. typhi* have been distinguished by phage typing. This method helps in finding the strain of the typhoid bacillus and in tracing the source of infection. For this purpose, the microorganisms isolated from the patient are compared with those of the suspected source by phage typing.

There are 3 antigens; O or somatic antigen, specific for the group; H or flagellar antigen, specific for the type; and Vi or virulence antigen. Rising titer of H antibody indicates typhoid fever while persistence of high titre of Vi indicates that a person is either a carrier or has been recently inoculated. The carrier state has to be confirmed by demonstrating the presence of *S. typhi* in the stools, urine or duodenum aspirate.

It is appropriate to comment here about diagnostic value of Widal's test in typhoid. As emphasised by Kamat,¹ though Widal test is generally accepted as a proof of enteric infection, this is far from true. It has many fallacies and is nonspecific. It remains negative in half to two-thirds cases in any one or more antigenic components. False positives can be encountered because *S. typhi* and *S. paratyphi* A share the antigenic structure not only with other salmonellae but also with some nonsalmonella enteric organisms. Antibiotics, TAB inoculation and other febrile diseases may alter the pattern of Widal antibodies. Because of these limitations, Widal's test cannot be used reliably for diagnosis of enteric fever.

Source of Infection

Source is the man harbouring the infection, either as a clinical or subclinical case or as carrier. Stools and urine of infected persons contain a large number of typhoid bacilli.

Period of Infectivity

The patient becomes infective after a week or 10 days and remains so for a week or two after the fever comes down. Carriers are infective for varying period and are of three types:

1. *Convalescent Carriers*: Usually the bacilli are passed during convalescence for 1 to 2 weeks after the temperature comes down. This period may be longer in some cases.
2. *Temporary or short term carriers*: They are fecal or urinary carriers who pass bacilli for 6 to 12 weeks. About 10 percent of untreated cases belong to this category.⁵
3. *Permanent carriers*: When gallbladder or kidney are involved, bacilli are passed for a long time with periods of remission in between 2.5 percent cases develop into such permanent carriers.⁵ Such persons should not handle milk, food or water. A person should be declared noninfective only when three weekly stool cultures are negative. Fecal carriers excrete around 10¹¹ organisms per gram of stool. Female carriers are three times more common than male carriers. Anatomical abnormalities in biliary tract favor the carrier state. Gallstones are particularly favorable sites for salmonellae to reside. The organisms can easily go

in and out of the stones. Organisms in the gallbladder are not affected by chloramphenicol even in inhibitory concentrations.¹ A carrier rate of 3.5 percent was found in stool culture survey of 450 food handlers in Bombay.⁶

Modes of Spread

- Carriers infect food, water, milk, icecream and other articles of food while handling.
- Water or milk-borne epidemics breakout when sewage finds its way into a drinking water channel or dairy water supply.
- Flies, fomites, dust and fingers also play some role in spread.
- Vegetables from sewage farms, especially if eaten raw, may cause infection. Shellfish and oysters infected by sewage entering the sea or near a beach may also be infective.
- Utensils washed in a polluted well, tank, or river water may get contaminated.

Susceptibility and Resistance

There is a general susceptibility to typhoid and no age or sex is immune. Persons with achlorhydria are more susceptible. Clinical disease, subclinical infection and active immunization provide some resistance to subsequent infection but this is only relative and does not provide protection when a large number of organisms are ingested.⁵ The attack rate usually declines with increasing age. Males suffer more than females but fatality is higher in the latter. Overall mortality without treatment is 10 to 25 percent. The carrier stage is more common in women. Some families are more prone than others.

INCUBATION PERIOD

10 to 14 days; varies from 4 to 21 days.

PREVENTION AND CONTROL

Measures of prevention and control in general are similar to those employed for cholera, though these are not strictly enforced. Food hygiene, environmental sanitation, routine immunization and specific treatment of cases need special emphasis.

IMMUNIZATION

Vaccines available for typhoid fever include the following.⁷

Inactivated whole cell vaccine: It is not recommended for use by the WHO or the CDC.

Live oral Ty21a vaccine: The vaccine has efficacy being 51 percent at 3 years. This is an orally administered, live attenuated Ty2 strain of *Salmonella typhi*. The lyophilized vaccine is available in two formulations:

a liquid suspension (in sachets) or as enteric coated capsules. Three doses of Ty21a capsules/sachets (liquid formulation) are administered on alternate days. It is also recommended that this series should be repeated once in every 3 years as a booster dose. The capsule should be taken orally with plain, cold or lukewarm water. The sachet should be given with 100 ml of safe water with buffer to protect the B-subunit against gastric acidity. Following the administration of the vaccine, food should be taken only after one hour. Proguanil and antibacterial drugs should not to be given for 3 to 7 days before and after the course of vaccine. This vaccine is contraindicated in pregnancy.

Injectable Vi polysaccharide vaccine: The vaccine has efficacy being 55 percent at 3 years. It is a subunit vaccine composed of purified Vi capsular polysaccharide from the Ty2 *S. Typhi* strain and elicits a T-cell independent IgG response that is not boosted by additional doses. The Vi vaccine is given as a single subcutaneous or intramuscular dose of 0.5 ml, and a booster is recommended once in every 3 years.

The expert group also recommends vaccination of the entire community at risk during an outbreak situation. If immunization of the entire community is not possible, the group recommends that the individuals aged 2 to 19 years should be specifically targeted. Due to insufficient data, the Expert Group currently does not recommend routine immunization of adults.

Vi-rEPA vaccine: Limited data are available on the Vi-rEPA vaccine.

Special Situations

HIV infection: The expert group recommends that in HIV seropositive individuals with a CD4+ T-lymphocyte count $>200/\text{mm}^3$, both Ty21a and Vi vaccines can be administered as in the case of immunocompetent individuals. However, in HIV-seropositive individuals with a CD4+ T-lymphocyte count $<200/\text{mm}^3$, Vi vaccine may be used.

TREATMENT OF CASES, CONTACTS AND CARRIERS

Cases: Chloramphenicol is very specific and has brought down the mortality to a very low level. Its main drawback is bone marrow depression, which is of two types, i.e. dose related and hypersensitive type. Fluoroquinolone such as ciprofloxacin 750 mg orally twice daily or levofloxacin 500 mg orally once daily, 5 to 7 days for uncomplicated enteric fever and 10 to 14 days for severe infection is the treatment of choice, because many salmonella strains are resistant to ampicillin, chloramphenicol, and trimethoprim-sulfamethoxazole. Ceftriaxone, 2 g intravenously for 7 days or azithromycin 500 mg orally for 7 days in uncomplicated cases is also effective.

Contacts: All contacts should be given vaccine.

Carriers: Chemotherapy often fails to eradicate the carrier state. While treatment with ampicillin, trimethoprim-sulfamethoxazole, or chloramphenicol may be successful, ciprofloxacin, 750 mg orally twice a day for 4 weeks, has proved to be highly effective. Cholecystectomy may also achieve this goal. All food handlers should be checked by stool culture and by enquiring for history of typhoid. Three stool examinations at weekly intervals should be negative before they are allowed to handle food. All food handlers should be trained to wash hands with soap after using the toilet. It is the carriers who maintain endemicity. The famous Typhoid Mary (Mary Malon), who cooked for eight different families during 1901–1914, was a permanent carrier and was responsible for seven epidemics involving more than 200 persons.

Paratyphoid Fevers (ICD-A01.4)

These are usually milder than typhoid and are often indistinguishable from it. The onset is abrupt with continuous fever lasting 1 to 2 weeks. The causative agents are *Salmonella paratyphi* A, B or C. Of these, paratyphoid B is the most common. A is less common and C is rare. Paratyphoid usually occurs in those places where typhoid is controlled. Foods such as milk, custard and icecream are the common vehicles. Source of infection is man, as in case of typhoid. Prevention and control measure are, likewise, similar. Chloramphenicol and antityphoid drugs provide effective treatment.

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Brucellosis (ICD-A23.9) (Undulant Fever, Malta Fever)

Identification

Fever of indefinite duration with irregular course, occurring in bouts of 1 to 2 weeks, followed by remission of uncertain and prolonged duration of 1 to 4 weeks. Other features are pain in joints, excessive sweating, specially in the early morning, and a relatively slow pulse. Spleen, liver and lymph glands may be enlarged.

There may be history of animal exposure or ingestion of unpasteurized milk or cheese.

LABORATORY TESTS

The clinical picture of brucellosis being often vague and nonspecific, no patient can be labeled as suffering from brucellosis without confirmatory laboratory tests. These are as follows:

Hemogram: The total leukocyte count is normal or slightly reduced, with a relative lymphocytosis.

Agglutination reaction: This is the most practical method for screening of suspected cases.¹ Agglutinins occur during the second or third week of illness but persist for years. A titer of 1:100 or higher, or a rising titer in paired sera, is a definite pointer to brucellosis infection. It may be mentioned that the agglutinins are not specific for brucellosis and cross react with *Vibrio cholerae* and *Pasturella tularensis*.

Brucella IgG antibody: The brucella agglutinating immunoglobulins consist of both 7S and 19S globulins. Out of these only 7S globulins are associated with active disease in acute or chronic cases.¹

Blood culture: This should be done in every suspected case of brucellosis, preferably more than once. The culture should be kept for six weeks before being labeled as negative. Bone marrow culture may be positive in the absence of a positive blood culture.

Isolation from urine, bile or feces: This can be done, but is impractical for routine purposes.

Intradermal test: Its usefulness is limited. As in the case of tuberculin test, a positive test may merely indicate old exposure and infection, without active disease being present.

HISTORY AND PREVALENCE

The disease was first noted in Malta, in 1906; that is why it is called Malta or Mediterranean fever. At present it occurs in sporadic form all over the world. Prevalence has been reported in India by different workers in Punjab, Delhi, Ahmedabad, Baroda, Jamnagar and Aurangabad.² A survey in Pune revealed 2 percent seropositivity for brucellosis among 306 blood samples from dairy farm workers while 2.6 percent of 500 milk samples from buffaloes and cows were positive for brucellosis.³ A survey by NICD⁴ reported that brucellosis seropositivity, (titer 1:180 or more by standard tube agglutination test) in persons suffering from fever of unknown origin was 3.3 percent in an urban area (Delhi) and 6.6 percent in a rural area (Jaipur). The seropositivity in animals with history of abortion was found to be 13.3 percent in goats and 14.3 percent in pigs. About 150 to 250 cases are reported every year

from the USA.⁵ It is primarily an occupational disease of those working with animals or their tissues, such as farm workers, veterinarians and butchers.

CAUSATIVE ORGANISMS, INFECTIVITY AND SOURCE OF INFECTION

Brucellosis probably ranks first among bacterial zoonoses in terms of human illness or economic loss.³ It is caused by small, nonspore forming nonmotile, gram negative bacilli belonging usually to the following three species:

1. *Brucella melitensis*: The infection is acquired through milk and meat of goats and is found more in Punjab. Uterine discharges after abortion in goats and sheep may infect the whole family.
2. *Brucella suis*: The source is meat of pig, hence it is found more in pork eating countries.
3. *Brucella abortus*: The source is milk and meat of cows. *Brucella* bacilli have also been isolated from sheep, horses, dogs and other animals including fowl. Unlike many other countries, *Brucella melitensis* infection is probably more common than *B. abortus* in India.³ There is no evidence of infection from man to man.

MODES OF TRANSMISSION

- By consumption of raw milk or meat of infected animals.
- Through meat, cheese, etc. contaminated by excreta of infected animals.
- Contact with infected animals and their discharges and tissues, especially placenta.
- Through abrasions in skin caused by infected hides or through cuts, such as those in laboratory workers.
- There is also some evidence of airborne infection in man in laboratory and slaughter house workers.⁵

Susceptibility

Men in 15 to 45 years age group are more susceptible.

Incubation Period

5 to 30 days, usually 2 to 3 weeks.

Prevention and Control

- *Raising brucella-free herds*: Immunization of calves and, sometimes, adult animals is recommended in areas of high prevalence.
- *Avoidance of raw milk and meat* of infected animals.

Treatment

The natural course of brucellosis in a majority of patients is marked by permanent remission of fever and other symptoms within 3 to 6 months. Rest is of special importance because persistence of fever and symptoms in brucellosis is definitely related to physical activity.¹ Tetra-

cycline is the antibiotic of choice, the dose being 0.5 g four times daily for at least 3 weeks for more seriously ill patients. Streptomycin 0.5 g twice daily may be used in addition.

Relapse rate of the disease is very high with single-drug regimens. So combination regimens of two or three drugs consisting of doxycycline and rifampin or streptomycin or gentamicin are best to prevent recurrence. Longer courses of therapy are preferred to prevent relapse of meningitis, osteomyelitis, or endocarditis.⁶

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Bacillary Dysentery or Shigellosis (ICD-A03.9)

Clinical Picture

A typical case is characterized by loose motions with blood, mucus and pus, accompanied by pain, griping and tenesmus (False desire to pass stools). The onset is sudden in acute cases and may be accompanied by fever, toxemia and exhaustion. Death may ensue rarely. Some cases become carriers of infection, usually for a short period. Rarely, the carrier stage may persist for months.¹

Epidemiology

Prevalence is worldwide, being more endemic in tropical countries where sanitation is poor. It is common among children below 10 years of age, many of whom may be asymptomatic. The severity of disease is primarily a function of general health and nutritional status, the disease being more serious in debilitated persons, particularly in old age. In such conditions, fatality rates up to 20 percent have been reported.¹

Causative Agent

The genus *Shigella* consists of nonmotile nonsporing, nonflagellate, rod shaped organisms belonging to four subgenera as follows: Group A (*Shigella dysenteriae*), Group B (*S. flexneri*), Group C (*S. boydii*) and Group

D (*S. sonnei*). Of these, group A, B and C are further subdivided into about 30 serotypes. The serotype often associated with serious disease is *S. dysenteriae* (Shiga's bacillus). However, the organisms most widely distributed in the world is *S. sonnei*.

Modes of Spread

They are same as in typhoid and cholera. Carriers and mild cases play important role, especially if they handle food and drinks.

Susceptibility

It is more in children, though no age is immune.

Incubation Period

It is 1 to 7 days (average 4 days).

Measures of Prevention and Control

Similar to typhoid and cholera. At present, no vaccine is available.

Treatment

Sulphonamides: Phthalyl sulphathiazole is given in a loading dose of 1.5 g followed by 1 g 4 hourly. Sulphaguanidine and succinyl sulphathiazole are required in larger doses. A 2 g loading dose of sulphadiazine followed by 1 g 4 hourly is also effective.

Antibiotics: Sulphonamides are no longer as effective for treatment of shigellosis as they used to be in the past because of the emergence of drug resistance. The antibiotic of choice at present is ampicillin, to which the organisms are sensitive in 95 percent cases.² The dose is 2 g daily in divided doses for 5 to 7 days. Sensitivity to tetracycline is found in 85 percent cases and this can be used when the organisms are resistant to ampicillin or when penicillin allergy is present. Chloramphenicol may have to be used in very serious circumstances. Oral streptomycin 0.5 g twice a day has also been recommended.³

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Amebiasis (ICD-A06.9)

Identification

Amebiasis denotes the condition of harbouring *Entamoeba histolytica*, with or without clinical manifestations: Amebiasis, may be intestinal or extraintestinal.

Intestinal amebiasis: It manifests in two distinct forms—amebic dysentery and amebic colitis. Amebic dysentery has an onset slower than bacillary dysentery, commencing with 3 to 4 bulky loose motions having fetid smell and containing blood and mucus. Amebic colitis is marked by thickening of cecum and sigmoid colon. Both forms tend to be chronic and are often associated with vague dyspeptic symptoms. Remissions and relapses are frequent. Many cases of intestinal amebiasis are asymptomatic cyst passers and serve as carriers. Diagnosis of intestinal amebiasis depends upon presence of trophozoite or cystic forms of *E. histolytica* in stools. At least three specimens should be negative to declare absence of infection. Stool culture may be performed for confirmation of diagnosis, if necessary.

Extraintestinal amebiasis: It manifests mostly as hepatic amebiasis which may be nonsuppurative or suppurative liver abscess. Very rarely, there may be involvement of lung, brain or spleen without apparent hepatic involvement.

Significant advances have been made during the last 20 years in immunodiagnosis of amebiasis as summarised below.^{1,2}

- Antiamebic antibodies develop only as a result of parenteral contact with amebae.
- Indirect hemagglutination (IHA) and indirect fluorescent antibody tests are very sensitive while the precipitin tests are relatively more specific. The most sensitive methods are IHA, ELISA (enzyme linked immunosorbent assay), indirect immunofluorescence and counter immunoelectrophoresis.³
- Antibodies persist for many years, hence no immunological test is available to differentiate between present amebic disease and past exposure to amebic infection. Also, antibody titer has no relation to severity of disease.
- IHA test is recommended as the screening method for clinically significant cases, a titer of 1/64 being significant (1/16 in some centers). Indirect immunofluorescence test titer of 1/200 and complement fixation titer of 1/16 are also considered positive.
- Immunodiffusion and IHA tests are positive in 95 percent cases of acute amebic dysentery and liver abscess.
- Seropositivity is found only in 57 percent cases of noninvasive amebiasis and in a still smaller proportion of persons with asymptomatic infection.

- Intradermal test is as highly sensitive as IHA, being positive in 90 percent cases of acute dysentery and 70 percent cases of liver abscess.

INFECTIOUS AGENT

Amebiasis is caused by infection with *Entamoeba histolytica*. This organism must not be confused with other amoebae, particularly *E. hartmanni* and *E. coli*. There are seven species of amoebae that naturally parasitise human mouth and intestine. Out of these, *E. histolytica* is the only one which causes disease.⁴ There are two different forms of the organism. In the non-invasive form, the trophozoite is about 10 to 20 μ m in diameter. In the invasive form, it is about 50 μ m in diameter. The cysts can remain viable for weeks in favorable conditions of low temperature and humidity. The trophozoite and cystic forms of *E. histolytica* are shown in **Figure 17.1**.

The parasite enters the body through oral route in the form of cysts. The trophozoite plays no role in transmission, being too fragile to stand external environment. Cysts cannot stand drying and are killed at temperature above 55°C. Chlorine can kill the organisms at a level of 2 ppm as against the usual level of 1 ppm used for chlorination. Sand holds the cysts back, hence sand filtration and chlorination, when combined, as effective. The cyst is more susceptible to iodine in comparison to chlorine.

Occurrence

It is a very common infection in the tropics but may also be common in subtropics and occasionally in temperate zones. Nearly 10 percent of the world population is affected including 2 to 5 percent in the USA.^{4,5} In Delhi, Dube *et al* found a prevalence of 9.7 percent in a random population.⁶ Chhuttani *et al* found 13 percent infection in medical students of Amritsar and 30 percent in their hostel kitchen staff.⁷ Prevalence is 5 to 10 percent in urban areas and higher in rural areas. Assuming an overall prevalence of 10 percent there would be 80 million cases of amebiasis in India.

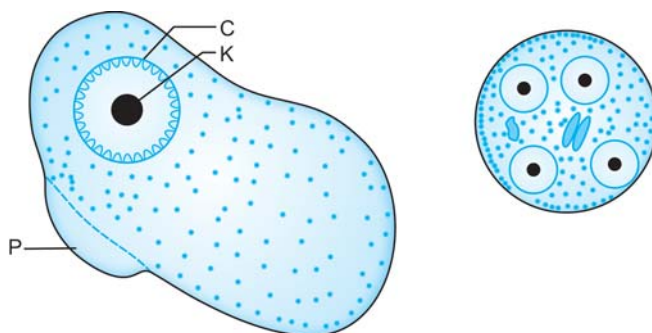


Fig. 17.1: *E. histolytica*, trophozoite and cystic forms

Reservoir

The source of infection is the man himself, usually chronic patients and asymptomatic cyst passers.

Modes of Transmission

Water polluted with sewage may cause an epidemic, the fecooral route being the predominant mode of entry. Food handlers, if they are convalescent or healthy carriers, play an important role. Flies and cockroaches can harbour cysts and contaminate food. Farm vegetables contaminated by sewage may infect man. Sexual transmission as a result of oroanal contact, especially among male homosexuals, has been increasingly reported during recent years. Poverty, ignorance and poor sanitation are favorable to the spread of disease in developing countries. Hot, dry climate is inimical to the cysts.

Incubation Period

Varies from a few days to months, even years. Commonly 2 to 4 weeks.⁸

Susceptibility and Resistance

Susceptibility to amebic infection is general, without any age or sex predilection. However, differences are seen in susceptibility to clinical disease. Thus, in temperate climates, symptomatic amebiasis is unusual below the age of 10 years. Intestinal and hepatic lesions are more frequent in adult males, this difference being independent of any higher exposure to infection in males.⁴ Amebic abscess of the liver is particularly prevalent in South Asia, South Western and Western and West Africa and Mexico. Only a low degree of immunity is produced, that too when *E. histolytica* attacks the tissues. Immunity to reinfection has not been clearly demonstrated.

Methods of Control

Preventive measures: Sand filtration effectively removes cysts in large water supplies. Chlorination, as usually practised (1 ppm), does not kill amebic cysts. Small water supplies can be efficiently rendered cyst free by using diatomaceous earth filters or by adding iodine. Eight drops of 2 percent tincture iodine or 12.5 ml saturated aqueous solution of iodine crystals can be added to a litre of water for this purpose.⁸ In case of doubt, water can be boiled before drinking. Sanitary disposal of nightsoil, hygienic habits, food hygiene and health education are important preventive measures, as in case of many other alimentary infections. Uncooked vegetables and fruits can be rendered free from amebic

TABLE 17.15: Drug therapy of amebiasis

• For asymptomatic intestinal carriers	
Iodoquinol	650 mg tid for 20 days
or Diloxanide furoate	500 mg tid for 10 days
• For mild to moderate intestinal disease	
Metronidazole	750 mg tid for 5 to 10 days
plus iodoquinol	As above
or diloxanide furoate	As above
or tetracycline	500 mg qid for 5 days
• For severe intestinal disease	
Above regimen plus	
dehydroemetine	1 to 1.5 mg/kg IM daily for up to 5 days
or emetine	1 mg/kg IM daily for up to 5 days
• For extraintestinal disease	
Metronidazole	As above
plus iodoquinol or chloroquine (150 mg Tab)	2 tds for 2 days 1 tds for 5 days 1 bd for 14 days
plus dehydroemetine or emetine	As above

Note: Tinidazole has not yet been shown to be superior to metronidazole and may be associated with less parasitological cure rate than metronidazole.³

cysts by disinfection with aqueous solution of iodine (200 ppm) or acetic acid (5 to 10%).

Control of Patients, Contacts and Immediate Environment

Simple, specific and very effective treatment is now available against amebiasis. Approach to treatment is summarised in **Table 17.15**.

The latest advance in treatment of amebic dysentery is a single dose regimen of secnidazole 2 g.

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Giardiasis (ICD-A07.1)

Identification

Mild infections cause no symptoms. Severe infection, especially in children, may cause loose motions and abdominal distension.

Cysts are found much more commonly than vegetative forms in the stools. Cysts are more clearly seen in iodine stained preparations.

Epidemiology

Giardiasis is cosmopolitan in prevalence and is found all over the world. The prevalence is more in children and in areas with poor sanitation. Prevalence has been reported to be about 20 percent in preschool children in a slum area in Delhi.¹ 21.5 percent prevalence in rural preschool children has been described in Guatemala.² Water-borne spread is common in communities without filtered water supply.³ Field studies indicate that giardiasis may predispose to development of protein calorie malnutrition in children.^{2,4} The causative agent is *Giardia lamblia* which lives in the duodenum and upper part of jejunum. The source of infection is infected man. Spread is by water and food contaminated with cysts through dust, flies, and fingers.

Methods of Control

Environmental sanitation, including safe disposal of excreta and clean water supply, are of crucial importance along with personal hygiene and health education. In emergency situations, water can be rendered safe by adding 0.5 ml of 2 percent tincture of iodine to one litre of water for 20 min.³ Treatment of infected individuals is essential to reduce the spread of infection. Drugs commonly used for chemotherapy⁵ are metronidazole 30 mg per kg once a day for three days (2 g daily for 3 days in adults) and tinidazole 30 mg per kg in a single dose (2 g for adults).

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Balantidiasis (ICD-A07.0)

It is a protozoal infection that may be asymptomatic when infection is light. Heavy infection is associated with attacks of diarrhea or dysentery which may vary from mild to fulminant disease.

Balantidiasis is cosmopolitan in prevalence. The causative agent, *Balantidium coli* is a large oval, ciliate protozoan, 70 to 100 µm long and 40 to 50 µm broad, actively motile with two nuclei. The cyst is 40 to 50 µm long and has a double wall. Both vegetative and cystic forms are seen in stools. *B. coli* is, in fact, the largest

protozoan infecting man. The source of infection is infected man or, sometimes, infected pigs. The mode of infection is similar to other dysenteries through the fecal-oral route. Tetracycline eliminates the infection.

Viral Hepatitis (ICD—B15-B19)

Hepatitis can be caused by many drugs and toxic agents as well as by numerous viruses. Six different types of viral hepatitis are now known. These are hepatitis A, B, C, D, E and G. The last has been discovered as late as 1996. Hepatitis A and E mainly spread through the fecal-oral route, usually through water. The other four are usually transmitted parenterally but are described in this chapter for sake of convenience. Of these, B and C types are most dangerous and type B is the most common.

All the six, though similar in many ways, differ greatly as regards etiological, epidemiological, immunological, pathological and clinical characteristics. All the hepatitis viruses can cause Acute Hepatitis, but B and C cause chronic hepatitis. In immunocompromised and rarely in immunocompetent persons cytomegalovirus, Epstein–Barr virus and herpes simplex virus may cause hepatitis. Severe acute respiratory syndrome (SARS) – coronavirus may also be associated with marked serum aminotransferase elevations.

Hepatitis A

IDENTIFICATION

This is the type of hepatitis which was commonly referred to as infective hepatitis earlier. The infection presents as three types of cases.

Typical Cases

These occurs in three phases. In the *pre-icteric phase*, fever, anorexia and nausea for 3 to 4 days are the common symptoms. Headache, vomiting and constipation in adults and diarrhea in infants and young children, may also occur. Epigastric discomfort may be present. Some cases remain mild and anicteric till the end. In the *icteric phase*, fever and anorexia are replaced by jaundice manifested by yellow coloration of conjunctiva and dark colored urine. Pulse is slow. Liver is palpable, tender and enlarged by 1 to 2 fingers below the costal margin. The convalescent phase may last for weeks or months. The patient continues to have general malaise, a feeling of tiredness and, sometimes, even tenderness of liver. The total illness usually lasts 30 to 40 days.

Severe Cases

They form about 25 percent of the total cases and start with chills and rigors which may be suggestive of malaria. The temperature goes upto 40.5°C. There may be aches and pains and prostration, as in influenza. Rarely, the disease may be fatal.

Mild Case

These are ambulatory cases and form the majority. 10 to 30 percent show no illness except slight jaundice or only coryza or biliousness. The spread of disease occurs more due to these cases than the severe ones.

Liver is the chief organ involved in viral hepatitis and shows inflammation and patchy necrosis. Resolution is usually complete. *Liver function tests* may be carried out as below:

- *Serum bilirubin*: Normal level of serum bilirubin is 0.3 to 0.5 percent mg. It rises to more than 1 percent mg in liver dysfunction.
- *Serum transaminases*: They are raised in 95 percent of the cases, even in the preicteric phase. The rise may be more marked in SGPT than in SGOT.
- *Serum alkaline phosphatase*: It may be markedly raised in cholestatic type of viral hepatitis.

Diagnosis is established by the demonstration of IgM antibodies against hepatitis A virus in the serum of acutely or recently ill patients; IgM may remain detectable for 4 to 6 months after onset. Diagnosis may also be made by a fourfold or greater rise in specific antibodies in paired sera; virus and antibody can be detected by RIA or ELISA. If laboratory tests are not available, epidemiologic evidence can provide support for the diagnosis. However, hepatitis A cannot be distinguished epidemiologically from hepatitis E in areas where the latter is endemic.¹

INFECTIOUS AGENT

The hepatitis A virus (HAV) is a 27 nm picorna virus (i.e. a positive strand RNA virus). It is a member of the family Picornaviridae and has been classified as *Enterovirus* type 72.¹ It can withstand a temperature of 56°C for half an hour and is resistant to freezing for a long time. Ordinary chlorination does not kill it but contact with chlorine for more than half an hour at 1 ppm reduces the virulence and number of viruses.

RESERVOIR

Patients and mild cases, especially the nonicteric and inapparent ones, are the major source of infection. Captive chimpanzees and, less frequently, other non-human primates, may also act as reservoir. An enzootic focus has

been identified in Malaysia, but there is no evidence of transmission to man.¹ The virus multiplies in oropharynx and intestine and is found in blood, stools and urine.

OCCURRENCE

The disease occurs in sporadic and endemic form all over the world, including towns with high sanitation standards, probably because the virus is not killed by ordinary chlorination. Large epidemics may occur in towns and villages when infection is spread through drinking water polluted with sewage. Pollution of Jamuna river caused havoc in Delhi in 1955 to 56, giving rise to more than 40,000 cases within 6 weeks.² Another epidemic occurred on a smaller scale in South Delhi in 1970 due to contamination of the Okhla water supply.³ Studies in Delhi have shown that the disease occurs throughout the year without any seasonal variation.⁴

MODE OF TRANSMISSION

It is mainly fecal-oral. Parenteral transmission through syringes and blood transfusion may also occur rarely. Overcrowding, poverty, unsafe water supply and insanitary conditions favor transmission and spread.

INCUBATION PERIOD

Varies from two to seven weeks (15 to 50 days) depending upon the infective dose. Average period is 4 weeks.

PERIOD OF COMMUNICABILITY

Infectivity is maximum during the latter half of the incubation period and continues during the acute phase of the disease for a few days after the onset of jaundice. Most cases probably become noninfectious one week after the jaundice appears.¹

SUSCEPTIBILITY AND RESISTANCE

Some common characteristics of water-borne epidemics of viral hepatitis in India are as follows:

- The epidemic is either accompanied or preceded by gastrointestinal infections.
- Incidence is higher in young adults than in children.
- Males are involved more frequently.
- Secondary cases are observed in about 20 percent families after a lapse of approximately 25 days.

There is no natural immunity. Acquired immunity through attack or subclinical infection is more or less permanent. Mortality is 1 to 2 percent among the weak and debilitated.

PREVENTION AND CONTROL

Notification for viral hepatitis should be compulsory.

Strict isolation as such is not needed. Proper precautions should be taken for “enteric isolation”, i.e. preven-

ting others from contact with the patient’s stools. This is needed during the first two weeks of illness and no more than one week after the onset of jaundice.¹ In addition, it is important to ensure that only disposable syringes and needles are used for a patient with viral hepatitis. If this is not possible these should be adequately sterilized after use.

Quarantine is not needed. Concurrent disinfection of stools is done as in cholera. As regards *water supply*, strong chlorination of water and guarding of catchment areas are the only sure methods to prevent epidemics. Sanitary disposal of excreta, antily measures and food hygiene are also important for prevention. As regards personal prophylaxis, *pooled human gamma globulin prophylaxis* for contacts has been found to be effective for 2 to 3 months. It should be administered as soon as possible, within 2 weeks after exposure. The dose is 0.02 to 0.04 ml per kg body weight given intramuscularly. Personal hygiene is, of course, very important.

There is no specific *treatment* for viral hepatitis. The forced bedrest recommended earlier has been found to be unnecessary. Good, adequate, nourishing diet without any fat restriction and with high energy intake has been shown to hasten recovery in controlled studies. There is no specific benefit associated with high intake of sugars, sweets or any particular vitamin as long as the general diet is wholesome and adequate. Corticosteroids are best avoided in management of viral hepatitis.

Vaccines

Vaccines available for immunization against hepatitis A virus (HAV) include (i) **Inactivated vaccines such as single antigen (HAV antigen) vaccines**, e.g. Havrix and Vaqta; and (ii) **combination vaccine**, e.g. Twinrix (containing both HAV and HBV antigens Glaxo Smith Kline) **Table 17.16.**

The Expert Group was of the opinion that universal immunization for hepatitis A is not required; but adults who are at risk for acquiring hepatitis A and negative for anti-HAV antibodies are likely to get the benefit. The high risk adults are (a) Persons who use illicit drugs; (b) Persons who work with HAV-infected primates or with HAV in a laboratory; (c) People who receive clotting factor concentrates; (d) Persons infected with other hepatitis viruses; (e) Persons with chronic liver disease who are not already immune to HAV;

TABLE 17.16: Vaccination schedule for hepatitis A

Age (years)	Vaccine	Dose	Route	No. of doses	Schedule (months)
1-18	Vaqta	0.5	IM	2	0, 6 – 18
	Havrix	0.5	IM	2	0, 6 – 12
≥19	Vaqta	1	IM	2	0, 6 – 18
	Havrix	1	IM	2	0, 6 – 12
	Twinrix	1	IM	3	0, 1, 6

TABLE 17.17: Identification of hepatitis B virus based-on antigen and corresponding antibody

Antigen	Antibody
Hepatitis B surface antigen (HBsAg)	anti-HBs
Hepatitis B core antigen (HBcAg)	anti-HBc
Hepatitis B E antigen (HBeAg)	anti-HBe

(f) Persons who have received or are awaiting a liver transplant; (g) Food handlers; and (h) Men who have sex with men (MSM).⁵

Hepatitis B

IDENTIFICATION

Hepatitis B virus is second only to Tobacco in causing cancer as an external agent. Complications such as cirrhosis and liver cancer mostly occur at around 35 to 40 years age, i.e. at the peak productive age. Loss of productivity, death and huge hospital expenses puts a huge burden on the family and society.

It is difficult to give definitive criteria for the identification of HBV infection in view of its varied presentation. In addition to acute viral hepatitis, well recognised complications are chronic carrier states, chronic persistent hepatitis (CPH) and chronic active hepatitis (CAH), cirrhosis and carcinoma of the liver.⁶ Chronic infections are mostly due to infections in infancy and childhood. Onset is usually insidious with anorexia, abdominal discomfort, nausea, vomiting and jaundice. Differentiation from hepatitis A is clinically difficult. Asymptomatic infection is common. Many cases may be revealed only by laboratory tests. Fulminant cases may result in fatal disease. Laboratory tests, besides those for liver dysfunction, include specific tests to detect the presence of viral antigens and the corresponding antibodies mentioned in **Table 17.17**.

The surface antigen can be detected in blood for several weeks before the onset of symptoms and persists for weeks or months. It persists for a long time in chronic infections. The core antibody (anti-HBc), an IgM, is present in high titer during acute infection and usually disappears within six months.¹ The presence of antigen e is associated with high infectivity, while the presence of antibody to e antigen is associated with relative (but not absolute) lack of infectivity.

STANDARD CASE DEFINITION⁷

Suspect (History)

An acute illness typically including acute jaundice, dark urine, anorexia, malaise, extreme fatigue and right upper quadrant tenderness. Biological signs include increased urine urobilinogen and >2.5 times the upper limit of serum alanine aminotransferase.

Confirmed (Laboratory Tests)

Serum positive for IgM anti-HBc or less desirably, hepatitis B surface antigen (HBsAg).

INFECTIOUS AGENT

Hepatitis B (**Fig. 17.2**) is caused by the hepatitis B virus (HBV) which is a 42 nm (one nanometer = 10^{-9} mm), partially double stranded DNA virus composed of a 27 nm nucleocapsid core antigen (HBcAg) surrounded by an outer coat containing the surface antigen (HBsAg). The HBsAg consists of several components designated as a, d, y, w and r. There are 4 subtypes of HBV, viz, adw, ayw, adr, and ayr. As is apparent, all these subtypes have a common antigen. More recently, a third type of antigen in addition to the core and surface antigens has been described. This is the e antigen (HBeAg) and is a soluble component, probably of the nucleocapsid.¹ Commercially available kits can be used to detect HBV antigens HBsAg and HBeAg, and the antibodies to these two antigens as well as to HBeAg.

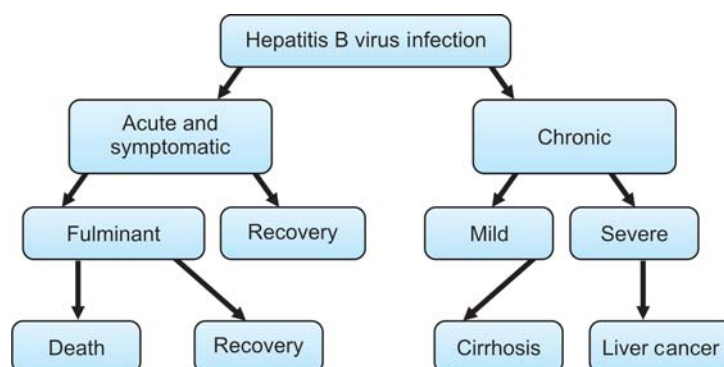


Fig. 17.2: Outcomes of hepatitis B virus infection⁸

OCCURRENCE

There is no seasonal variation. In developing countries, the infection is widespread in children but is most common in young adults in the West. In certain parts of Asia, an antigen carrier rate as high as 10 to 15 percent has been found. Carrier rate for surface antigen is 4 percent in India.⁹

RESERVOIR

Man himself is the chief source of infection. Captive chimpanzees may also act as reservoir of infection, but transmission to man has not been demonstrated.¹

Mode of Transmission

Transmission may occur by the following routes:

Parenteral or Percutaneous

Through infected blood, blood products, syringes, transfusion apparatus, etc. and, occasionally, even razors, nail clippers and tooth brushes. HBV infection is thus more common in nurses, surgeons, drug addicts and those receiving repeated transfusion, such as hemophiliacs, coronary bypass patients and those on hemodialysis. An epidemic of HBV infection occurred among medical and paramedical staff of the largest hospital in Ahmedabad, killing hundreds of young people and resulting in the closure of the hospital for a few weeks.

It may be mentioned that hepatitis B virus is much more infective than the HIV virus responsible for AIDS. While 0.1 ml infected blood is needed for transmission of HIV, only one thousandth of this amount is needed for transmission of hepatitis B. That is why blade cuts or pin pricks caused by an infected instrument can transmit hepatitis B but not HIV.

Vertical or Perinatal Spread

Mother to infant transmission can occur when the mother is a chronic carrier or suffers from acute HBV infection during the last trimester of pregnancy. The infection might occur during birth (through ingestion of amniotic fluid or blood), but more likely it occurs during the postnatal period as a result of close contact. More than 90 percent of infants infected by their mothers become chronic carriers as their immature immunological system is not able to clear the virus.

Per mucosal Spread

Though HBsAg has been found in virtually all body secretions and excretions, only blood, saliva, vaginal fluid and semen have been found to be infective.¹ Presence of e antigen greatly enhances the infectivity of these fluids. Thus sexual partners of HBV infected persons stand the risk of contacting the infection. This

is true of homo as well as heterosexual partners. Simple kissing and even accidental ingestion of HBsAg positive blood during pipetting may transmit the infection. Hepatitis B can be transmitted from child to child during play or from an adult (who is infected but looks healthy) to child by contact of body fluids through minor cuts, sores, abrasions etc. In fact child to child (also adult to child) is the **most common mode of transmission** of hepatitis B. It also transmits through unprotected sexual contact.

Through Vectors

HBsAg has been found in mosquitoes and bedbugs. However, their role, if any, in the transmission of infection is not known.

INCUBATION PERIOD

Varies from 45 to 180 days, average 60 to 90 days, may be rarely as long as 6 to 9 months. It may take as short as two weeks for HBsAg to appear in the blood.¹

PERIOD OF COMMUNICABILITY

Blood of experimentally inoculated volunteers is infective several weeks before the onset of symptoms and remains so throughout the acute clinical disease and the chronic carrier state. The latter may persist for years. HBsAg and/or anti-HBcAg are demonstrable in the blood of most, if not all, carriers. Chronic antigenemia may occur even after asymptomatic infections. The possibility of chronic antigenemia is more in infants, on persons on hemodialysis and in those with immunodeficiency (e.g. Down's syndrome and lymphoproliferative disease).

SUSCEPTIBILITY AND RESISTANCE

There is general susceptibility to infection. Immunity conferred is solid. The disease is usually milder in children. In 10 percent infected individuals, the virus persists in blood for more than 6 months. These are called chronic carriers. The carrier state usually lasts in these persons indefinitely, though the HBV may sometimes disappear in course of time. Only 10 to 20 percent of the chronic carriers are highly infectious. In countries like Africa with a very high prevalence of chronic carrier state in general population (about 15 %), the incidence of hepatocellular carcinoma is very high.

PREVENTIVE MEASURES

The following steps are important:

- Avoid spilling blood during collection, storage and transport. Avoid all unnecessary injections, infusions and venepunctures. Always use disposable needles and syringes for HBsAg positive patients. Wash thoroughly hands contaminated with blood.

- Blood donors and the staff of blood banks, hemodialysis units, pathology laboratories and operation theatres should be screened for HBsAg positivity every 3 to 6 months.
- Blood transfusion should be given only when absolutely necessary. Pooled plasma should be avoided. Patients needing multiple blood transfusions should be immunized with vaccine if found to be negative for anti-HBs (antibody to HBsAg).
- Antenatal care should include, whenever possible, routine screening for HBsAg to prevent perinatal transmission to infants.
- **Passive immunization** by administration of immune serum globulin (ISG) or hepatitis B immunoglobulin (HBIG). The latter contains a high titer of anti-HBs compared to ISG. The indications are as follows:
 - ISG: 0.02 ml/kg is given to household contacts, especially children, of patients with hepatitis, as also to persons proceeding to areas where the infection is endemic. When blood transfusion is given to a patient 5 ml may be given intramuscularly on the day of transfusion to prevent development of post-transfusion hepatitis.
 - HBIG: Its specific indication is in case of infants born to HBsAg and HBcAg positive mothers, the dose being 0.5 ml IM at birth and repeated at 2 and 6 months. It is also indicated in adults in a single dose of 5 ml IM repeated after one month.
- **Active immunization:** Hepatitis B vaccine is the first vaccine against a cancer (primary liver cancer). This vaccine is available either as monovalent or in combination (DPT-HepB, DPT-HepB+ Hib and HepB-Hib, etc.). Combination vaccines (Pentavalent: already discussed) expected to be introduced in NIS from 2009 to 10. The currently used hepatitis B vaccine in UIP are prepared by using the HBsAg grown in yeast cells by DNA recombinant technology and it contains only the outer coat (surface antigen) of the virus. Government of India recommends birth dose of hepatitis B within 24 hours for all Institutional deliveries to prevent perinatal transmission of infection. In addition 3 doses should be given at 6, 10 and 14 weeks irrespective of the birth dose (at the same time as DPT but at different sites). Route is intramuscular and the site being anterolateral aspect of thigh in infants. Vaccine is available as 10-dose vial of liquid vaccine in the program.⁸

For immunocompetent adults, 20 µg of recombinant vaccine is administered at 0, 1 and 6 months as an intramuscular injection in the deltoid using a 24 to 38 mm needle. Protection (defined as anti-HBs antibody titer of 10 mIU/ml or higher) following the first, second and third doses of the recombinant

vaccine has been observed to be 20 to 30 percent; 75 to 80 percent; and 90 to 95 percent respectively. Hepatitis B vaccination is indicated for all unvaccinated adults at risk for HBV infection and all adults seeking protection from HBV infection including postexposure prophylaxis.¹⁰ Children below 10 years to age should receive half to the adult dose, i.e. 10 µg.

Side Effects

Most common side effects are soreness at injection site, fatigue, headache, irritability and fever higher than 37.7°C.

Efficacy

Complete vaccine series induces protective antibody levels in 95 percent infants.

Storage

The vaccine is to be stored and transported at +2 to +8°C. This vaccine is **highly freeze sensitive**. Vials should not come in direct contact with icepack or ice or the wall and floor of ILR. Freezing breaks the bond between hepatitis B surface antigen (HBsAg) and the alum adjuvant, thus loses its immunological potency.

HEPATITIS B VACCINATION AND RHEUMATOID ARTHRITIS

GACVS considered the potential association of hepatitis B vaccination (HBV) and rheumatoid arthritis (RA) among a particular genetically-determined subgroup. However, based on a review of the limited data, no convincing evidence was documented to support an association between HBV and RA.¹¹

Hepatitis C

IDENTIFICATION

Onset is usually insidious, with anorexia, vague abdominal discomfort, nausea and vomiting, progressing to jaundice less frequently than hepatitis B. Severity ranges from inapparent cases to fulminating, fatal cases (rare). Chronicity is common, occurring more frequently than with hepatitis B in adults. Chronic infection may be symptomatic or asymptomatic. Chronic hepatitis C may progress to cirrhosis, but more often improves clinically after 2 to 3 years. Hepatitis C infection may also ultimately lead to cancer of the liver. It is reported that 85 percent of hepatic carcinoma in Japan is associated with hepatitis C.

Diagnosis depends on the exclusion of hepatitis A, B and delta viruses and other causes of liver injury. A serologic test for antibody to the agent has been developed. The Indian strain has been labeled as 3 h.

INFECTIOUS AGENT

There is evidence for more than one type of agent from epidemiologic and transmission studies in primates. A putative agent has been identified. The lipid-enveloped agent is between 30 and 50 nm in diameter; it is a positive-strand, RNA virus, probably a flavivirus.

OCCURRENCE

Hepatitis C is parenterally transmitted and has been found in every part of the world where it has been sought. It is the most common post-transfusion hepatitis in the USA, accounting for approximately 90 percent of this disease, and is more common when paid donors are used. Most cases are not associated with blood transfusion and hepatitis C accounts for 15 to 40 percent of community-acquired hepatitis cases. Antibodies to the hepatitis C virus are found in samples from around the world. 5 percent blood donors at AIIMS have been found to be hepatitis C positive.

RESERVOIR

Man has been transmitted experimentally to chimpanzees.

MODE OF TRANSMISSION

As in case of hepatitis B.

INCUBATION PERIOD

Ranges from 2 weeks to 6 months; most commonly, within 6 to 9 weeks.

PERIOD OF COMMUNICABILITY

From one or more weeks before onset of the first symptoms through the acute clinical course of the disease, and indefinitely in the chronic carrier states.

SUSCEPTIBILITY AND RESISTANCE

Susceptibility is general. The degree of immunity following infection is not known; repeated bouts of acute hepatitis C have been reported.

METHODS OF CONTROL

Similar to hepatitis B. The value of prophylactic IG is not clear.

Peginterferon or interferon alfa is used to treat acute hepatitis C for 6 to 24 weeks. Ribavirin may also be used if HCV RNA fails to clear after 3 months of peginterferon or interferon alfa therapy. Antiviral therapy is usually unnecessary in patients with acute hepatitis B.

Hepatitis D

IDENTIFICATION

Onset is usually abrupt, with signs and symptoms resembling those of hepatitis B. Hepatitis may be severe and is always associated with a coexistent hepatitis B virus infection. Delta hepatitis may be self-limiting or it may progress to chronic hepatitis. Hepatitis delta virus (HDV) and hepatitis B virus (HBV) may coinfect, or delta virus infection may be superimposed upon the HBV carrier state. In several studies throughout Europe and the USA, 25 to 50 percent of fulminant hepatitis thought to be caused by HBV was associated with concurrent infection with HDV.

INFECTIOUS AGENT

HDV is a 35 to 37 nm virus-like particle consisting of a coat of HBsAg and a unique internal antigen, delta antigen. HDV is unable to infect a cell by itself and requires coinfection with HBV.

Occurrence

Worldwide, with marked variation in prevalence. Occurs epidemically or endemically in populations at high risk of HBV infection.

MODE OF TRANSMISSION AND METHODS OF CONTROL

Similar to that of HBV.

INCUBATION PERIOD

Approximately 2 to 10 weeks for experimental infections in chimpanzees; not firmly established in man.

Hepatitis E

IDENTIFICATION

The epidemiology and clinical course are similar to that of hepatitis A; there is no evidence of a chronic form. The case fatality rate is similar to that of hepatitis A, except in pregnant women where the rate may reach 20 percent during the third trimester of pregnancy.

Diagnosis depends on exclusion of other etiologies of hepatitis, especially hepatitis A, by serologic means. A serologic test is being developed for hepatitis E.

INFECTIOUS AGENT

There is evidence that one virus or virus family is responsible for hepatitis E. A 32-nm virus-like particle has been found in stools during the early acute phase

of infection with a sedimentation coefficient of 183 S (compared to 157 S for HAV).

OCCURRENCE

Epidemics consistent with a hepatitis E virus etiology have been identified in many developing countries, including India.

The attack rate is highest in young adults, often with a male predominance. Cases are uncommon in children and the elderly.

RESERVOIR

Man, transmissible to chimpanzees.

MODE OF TRANSMISSION

Contaminated water. Also probably from person to person by the fecal-oral route.

INCUBATION PERIOD

Fifteen to 64 days; mean incubation period has varied from 26 to 42 days in different epidemics.

PERIOD OF COMMUNICABILITY

Not known, but may be similar to hepatitis A.

METHODS OF CONTROL

Similar to hepatitis A.

Hepatitis G

This virus was discovered in January 1996. It is a flavivirus that is percutaneously transmitted and associated with chronic viremia that lasts for at least 10 years. HGV has been detected among blood donors, injection drug users, hemophiliacs, hemodialysis patients and with chronic hepatitis B or C infection, but it does not cause important liver disease.

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Poliomyelitis (ICD-A80.9)

India appears to have interrupted wild polio virus transmission, completing one year without polio since its last case on 13/L/2011.

Identification

Clinically the disease is seen in 3 forms:¹

CLINICAL ASPECTS

In 90 to 95 percent of poliovirus infected individuals, infection is inapparent and in the remaining 5 to 10 percent of individuals, one of the three syndromes may occur.

- Abortive polio:** Occurs in 4 to 8 percent of infections and is characterized by minor illness with low grade fever, malaise, sore throat, vomiting, abdominal pain, and loss of appetite. Recovery is rapid and complete, there is no paralysis. It cannot be distinguished from other viral infections causing mild respiratory tract or gastrointestinal infections.
- Nonparalytic aseptic meningitis:** Occurs in 1 to 2 percent of infections and is characterized by headache, neck, back and leg stiffness several days after a prodrome similar to abortive polio. Cases recover within 2 to 10 days. It cannot be distinguished from other causes of aseptic meningitis. Illness may reach imminent paralysis but soon reverts back.
- Paralytic poliomyelitis:** Occurs in 0.5 to 1 percent of infections. Symptoms often occur in two phases, minor and major and are often separated by several days without symptoms. Minor phase consists of symptoms similar to those of abortive poliomyelitis. The major phase of illness begins with muscle pain, spasms and the return of fever. This is followed by rapid onset of flaccid paralysis that is usually complete within 72 hours.
 - Spinal form:** This is probably the most common form of paralytic muscles is asymmetrical and the extent of paralysis is variable. Paralytic manifestation in extremities begin proximally and progress to involve distal muscle groups (i.e. descending paralysis). Residual flaccid paralysis is usually present after 60 days. Severe cases may develop quadriplegia and paralysis of the trunk, abdominal and thoracic muscles. Affected

muscles are floppy and reflexes are diminished. Pain and touch sensations are normal.

- b. *Bulbar and bulbospinal forms*: These account for only 10 percent cases of paralytic poliomyelitis and are usually life threatening. Pure bulbar form is rare. Pure bulbar form is rare and results from a cranial nerve lesion, resulting in respiratory insufficiency and difficulty in swallowing, eating or speaking.
- c. *Encephalitic form*: The child may be irritable, delirious, disoriented or stuporose and may have convulsions.

The fatality rate of paralytic cases is 2 to 10 percent.²

STANDARD CASE DEFINITION OF POLIOMYELITIS

Suspect (history): Sudden onset of weakness and floppiness in any part of the body in a child less than 15 years of age or paralysis in a person of any age in whom polio is suspected.

Probable (history and clinical examination): Epidemiologically linked case.

Confirmed (laboratory tests): Isolation of wild polio virus from stool.

RESIDUAL PARALYSIS

As the acute phase of illness (0 to 4 weeks) subsides, the recovery begins in paralyzed muscles. The extent of recovery is variable ranging from mild to severe residual paresis at 60 days, depending upon the extent of damage caused to the neurons by the virus. Maximum neurological recovery of paralyzed muscle takes place in first 6 months and slow recovery continues up to two years. After two years, no more recovery is expected and the child is said to have 'Post Polio residual paralysis', which remains through out life.

DIFFERENTIAL DIAGNOSIS OF ACUTE FLACCID PARALYSIS

(i) Paralytic poliomyelitis, (ii) Guillain-Barre syndrome, (iii) Traumatic neuritis, (iv) Transverse myelitis, (v) Encephalitis, (vi) Meningitis, (vii) Other enterovirus infections (Coxsackie A, Coxsackie B, ECHO virus, Mumps virus etc.), (viii) Metabolic imbalances (diabetes), (ix) Toxins (lipid solvents, fish toxin, diphtheria toxin), (x) Organophosphate pesticide, raw metal (lead), (xi) Hereditary disease (Charcot-Marie-Tooth), and (xii) Tumors.

Surveillance is carried out for all cases of acute flaccid paralysis, and not just for poliomyelitis alone.

DIAGNOSTIC TESTS

Following are the available diagnostic tests:

Stool: Recommended in every case of surveillance. Highest probability of detection of virus is during first 2 weeks after onset of paralysis.

Cerebrospinal fluid: It is not recommended for surveillance. Cerebrospinal fluid shows excess leukocytes, with lymphocytic predominance; count is rarely more than 500/mcL. Often carried out to exclude other conditions.

Throat: Not recommended for surveillance.

Blood: It is also not recommended for surveillance. Rise in antibody titre may occur after onset of paralysis.

TREATMENT OF PARALYTIC POLIOMYELITIS

(i) Complete bed rest in; comfortable but rotating positions should be maintained in a "polio bed": firm mattress, footboard, sponge rubber pads or rolls, sandbags, and light splints, massage or intramuscular injection is contraindicated during the acute phase, (ii) Correct positioning of affected limbs, (iii) Passive movements and physiotherapy of the joints after the acute phase subsides, (iv) Warm water fomentation, (v) Symptomatic treatment for fever and pain, (vi) Have to report immediately if there is progression of paralysis and (vii) Orthopedic surgery for deformities or contractures.

If there is progression of paralysis, respiratory distress, bulbar involvement, marked drowsiness and paralysis of upper limbs of less than 3 days duration, the patient should be hospitalized immediately.

INFECTIOUS AGENT

The poliovirus is an RNA virus belonging to family picornaviridae and genus enterovirus. It is a neurotropic virus and has 3 antigenic types. Type 1 and 3 are more virulent and invasive while type 2 is mild. Type 1 is the most prevalent as also the most paralytogenic. Type 3 is the least prevalent. The virus can live in sterile water for 100 days and for a longer time in sewage. It is highly resistant to alcohol, phenol and formalin. It is inactivated by the usual water chlorination, pasteurisation and ultraviolet light as also by 2 percent iodine and oxidising agents such as potassium permanganate. Type 1 is Brunhilde, Type 2 is Lansing and Type 3 is Leon.

OCCURRENCE

The virus has a worldwide distribution. Till recently, epidemics of the paralytic disease occurred most frequently in the highly developed countries. A notable change in pattern of poliomyelitis has occurred in the developing countries. Paralytic poliomyelitis was recognised in India only in 1947 when one of the most severe epidemics occurred in Andamans Islands. The incidence of polio increases rapidly after 6 months of age. According to Dr Jacob John,³ 20 to 30 percent

TABLE 17.18: Occurrence of Poliomyelitis (Year wise)

Year	No. of cases	
	Global	India
2003	784	225
2005	1979	66
2006	1997	676
2007	1315	874
2008	1651	559
2009	1232	741

cases of polio occur between the ages of 7 to 12 months. 90 percent of children aged up to 5 years show the presence of neutralising antibodies to all the three types of polioviruses. There is an ominous trend towards increase in the number of cases of paralytic poliomyelitis along with an improvement in the standard of living.⁴ This is related to the fact that the first exposure to poliovirus is delayed in countries with a higher standard of living and that the incidence of paralytic polio following poliovirus infection increases with increasing age (**Table 17.18**).

The WHO regions that have been certified as polio-free are Americas (certified in 1994), Western Pacific Region (certified in 2000) and European region (certified in 2001).

In 2009, globally 40.4 percent cases came from India, followed by 30.9 percent cases from Nigeria and 5 percent cases from Pakistan. This year there has been sudden increase in the number of cases in two countries, e.g. in Benin (1.6 %) and Sudan (3.6%), compared to previous years.

In India, initially most cases were due to Type 1, but for the last three years, there has been change in serotype from Type 1 to Type 3 (**Fig. 17.3**). In India, majority of the cases (79.7%) came from Uttar Pradesh in the year 2009⁵ (**Table 17.19**).

TABLE 17.19: Location of wild poliovirus in India by type in 2010

State	P 1	P 3	Total
Jammu and Kashmir	1	0	1
Maharashtra	1	0	1
West Bengal	1	0	1
Uttar Pradesh	0	9	9
Bihar	0	6	6
Haryana	0	1	1
Total	3	16	19*

*Total 42 cases were reported in 2010. This 19 was upto mid 2010.

Moradabad district is a densely populated region in western Uttar Pradesh that has had continuing wild polio virus transmission despite ongoing polio eradication efforts; including supplemental immunization activity (SIA) targeting all children aged < 5 years roughly every 6 weeks. The low OPV coverage achieved through routine immunization activities (~38%), and the combination of crowding, high diarrhea rates, poor sanitation as well as a warm and humid climate have contributed to persistent poliovirus transmission.⁶ In 2011, India reported a single case of polio in a 2-year-old girl in West Bengal on 13th January 2011.

RESERVOIR

Man is the only reservoir. Paralytic patients as well as mild, missed and inapparent cases discharge the virus in oropharyngeal secretions and stools. The virus is demonstrable in the throat as early as 36 hours after infection and persists for about 1 week. It can be demonstrated in feces 72 hours after infection and persists for 3 to 6 weeks or longer.² In tropical countries the virus does not survive in environment outside the human body for more than few days.

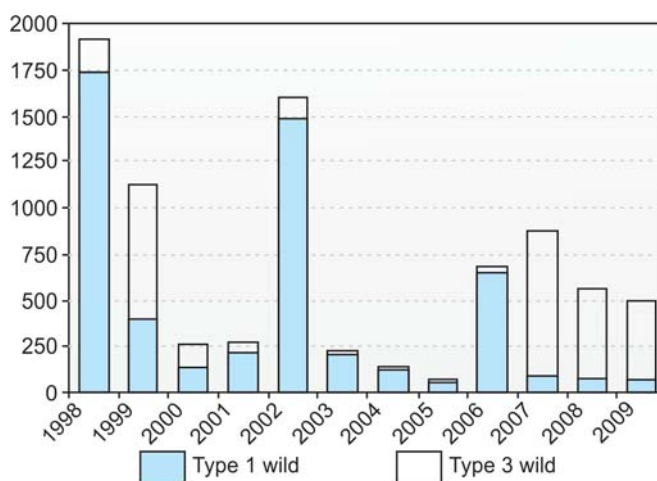


Fig. 17.3: Distribution of polio cases in India over the years

Cases are probably most infectious during the first few days following infection. There are no long-term carriers.

MODE OF TRANSMISSION

The transmission is mainly by direct contact through fecal-oral route. It occurs usually through close contact, but rarely through milk, water or food that is fecally contaminated. However, water is rarely involved and there is no reliable evidence of spread through water contaminated with sewage. Polio virus is intermittently excreted for up to 2 months or more after infection, with maximum excretion occurring just before paralysis and during first 2 weeks after onset of paralysis. Transmission by pharyngeal route (droplet infection) is less common, but may be relatively more important during epidemics and in countries with a high level of sanitation.²

INCUBATION PERIOD

It is 7 to 14 days for paralytic cases, the range being 3 to 35 days.²

PERIOD OF COMMUNICABILITY

Poliovirus is highly communicable. The cases are most infectious one week before and two weeks after onset of paralysis. An infected individual will probably infect all other persons in household and close contacts, especially where sanitation is poor. The virus can be demonstrated in throat secretions and stools within 56 to 72 hours after exposure in both clinical and subclinical infections. The virus persists for about a week in the throat and for 3 to 6 weeks or longer in the stools.²

SUSCEPTIBILITY AND RESISTANCE

In tropical countries, poliomyelitis is still a disease of childhood, most cases occurring under 5 years of age. Infants born to mothers with antibodies are protected naturally against paralytic polio for few weeks. However, any immunity conferred during the early neonatal period is short lived highlighting the importance of OPV as early as possible in the newborn. Incidence is highest in the age group six months to three years with a peak at two years. It is rare after five years of age. In countries with better sanitation, the age incidence is rising and the total incidence is falling because of regular immunization.

Muscular fatigue, chills, and pregnancy predispose to development of paralytic polio. Administration of an intramuscular injection to a person who has been freshly infected tends to precipitate a paralytic attack.⁴ Immunity produced by inoculation or natural infection is type-specific and long lasting. Second attacks are rare and are attributable to infection by a different strain.

PREVENTION AND CONTROL

The success of immunization with polio vaccine has created history in modern medicine. The vaccine is of two types. The Salk vaccine, introduced in 1954, is an inactivated polio vaccine (IPV) administered parenterally. The Sabin vaccine, introduced in 1961, is a live oral polio vaccine (OPV) prepared from an attenuated strain and is given orally. The WHO recommends the OPV. It has the following advantages over IPV:

- It is more effective in stopping the spread of wild polioviruses. Unlike IPV, it multiplies and stimulates immunity in the intestine, thereby inhibiting the growth of the wild strain and its transmission to others.
- It is easier to administer.
- It is cheaper.
- It provides longer immunity, at least for 3 years.
- In contrast to IPV, it is useful in control of epidemics.
- OPV is excreted in stools for 4 to 6 weeks after a dose is administered. The contacts of the person immunized may also thus develop immunity.

OPV is prepared from selected, attenuated strains of the three types of poliovirus cultured on monkey kidney.

Recommended schedule: In India, infants should receive routine primary OPV doses at the age of 6, 10 and 14 weeks. A dose at birth (birth dose) is recommended if the child is delivered institutionally. Booster dose is recommended at 16 to 24 months of age along with DPT booster. Polio vaccine may be given simultaneously with any other childhood vaccines. OPV can be given to children till 5 years of age.

Dosage, administration and formulation: OPV is given orally after shaking the vial. Each single dose consists of two drops (0.1 ml) of live oral poliovirus vaccine.

Trivalent OPV or tOPV, containing all three poliovirus serotypes (1, 2 and 3) is used, both for routine immunization and in some PPI rounds. Each dose contains not less than $10^{6.0}$, $10^{5.0}$ and $10^{5.8}$ CCID₅₀ of poliovirus type 1, 2 and 3 respectively. This vaccine has been stabilized with MgCl₂. Kanamycin and neomycin sulphate has also been added per dose not more than 20 mcg. each. Monovalent OPV or mOPV containing either Type 1 or 3 has been in use in India during recently. Some polio vaccines are light pink in colour due to phenol red, used as a pH indicator. Infants can be breast fed immediately after OPV administration.

OPV being a live vaccine given in multiple times: Because of presence of other entero viruses in the gut, one particular dose may not be able to replicate and may not have any effect. Out of three serotypes of OPV only one serotype is able to get a foothold in the intestine and at the same time it does not allow other two serotypes for replication. Thus to ensure seroconversion against all the three serotypes, multiple doses of tOPV are required.

Storage: OPV is one of the most heat sensitive vaccines and it should be stored below 8°C. Unopened vials of OPV may be stored for up to 6 months at minus 20°C.

Contraindications: Acute febrile illness, immunocompromised host, severe diarrhea and pregnancy. As such diarrhea is not a contraindication, but the dose should not be counted and another dose should be given at the first opportunity. This is because the virus may not have been able to establish itself in the intestine due to diarrhea.

In all these cases IPV can be given safely, if required. A child who has recovered from polio, should also receive trivalent OPV to safe guard against the other serotypes of polio virus.

OPV VS. IPV

Once wild poliovirus transmission will be interrupted globally, then OPV use will eventually be stopped in routine immunization programs, just to eliminate the rare risks posed by vaccine-derived polioviruses (VDPVs); as recommended by the Advisory Committee on Polio Eradication.

PULSE POLIO IMMUNIZATION (PPI)

A unique approach towards polio eradication is pulse polio immunization. In this approach, all children in the country are simultaneously administered OPV on a single fixed day, repeated after 4 to 6 weeks. As a result, the wild poliovirus strains get replaced by the harmless and protective OPV strain.

The word pulse denotes “sudden, simultaneous mass administration of OPV on a single day to all children 0 to 5 years of age”. In order to be effective, very high percentage of OPV coverage must be attained during each pulse.

The PPI program was launched in India in 1995 with the aim to eradicate polio by the year 2000. The first round consisted of two pulses on Dec 19, 1995 and January 20, 1996. It was targeted at children below 3 years. From second round below 5 years of children were covered.

The response from people was enthusiastic.⁷ In the second round (December 7, 1996 and January 18, 1997) about 120 million children were immunized on each day.⁸

Polio eradication can be certified only when no indigenous cases of clinical poliomyelitis occur for three years and when no wild poliovirus is found in the community and the environment in spite of intensive efforts. The target was to certify India to be polio-free by December 2005.

POLIO ERADICATION

Leaders of various nations decided at the World Summit of Children, 1990, to eradicate polio by the year 2000.

It has already been eradicated in the American continent. The total cost of the campaign was \$ 500 million. Today, the whole of the Western hemisphere is polio-free. The same is also probably true of the Western Pacific region.

The campaign to eradicate polio from the world will cost \$ 1100 million. The cost effectiveness of such expenditure is clear from the fact that the annual vaccination expenses alone cost around \$ 500 million.⁹ There is distinct possibility that the objective of polio eradication will be achieved in India soon. Polio eradication is not solely the elimination of the disease, paralytic poliomyelitis but it is the global interruption of transmission of wild polio virus.

Epidemiological Basis for Polio Eradication

Poliomyelitis is eradicable because:

- Man is the only host
- Long-term carrier state is not known to occur
- The half-life of excreted virus in the sewage is about 48 hours and spread can only occur during this period
- OPV is easy to administer and does not need highly trained personnel
- OPV is cheap
- OPV is ideally suited for polio eradication because the live vaccine virus multiplies in the intestine and can interrupt the transmission of the wild poliovirus. The vaccine virus mimics the natural route of infection, and can also be transmitted from a recently vaccinated child to close contacts who have not been vaccinated. Herd immunity is achieved in case of poliovirus if two thirds of the community is immunized.

STRATEGIES FOR POLIO ERADICATION

- **Routine immunization:** This is carried out as per national Immunization Schedule.
- **Supplementary immunization activity (SIA):**
 - *NID (National Immunization Day):* the entire country is covered with OPV.
 - *SNID (Sub National Immunization Day):* some states or parts of states are covered.
 - *Mop up immunization:* final end game strategy; when wild virus transmission is very much focal
- **Surveillance of acute flaccid paralysis (AFP):** This is done to identify areas of wild polio virus transmission and to guide immunization activities accordingly.

Vaccine-derived Polioviruses

Vaccine-derived polioviruses (VDPV) are defined as live, attenuated strains of the virus contained in the oral polio vaccine (OPV) which have changed and reverted to a form that can cause paralysis in humans

with the capacity for sustained circulation. VDPVs differ from the original Sabin strains found in the vaccine by 1 to 15 percent of VP1 nucleotides. The measurement of genetic change monitors the circulation of viruses

Circulating vaccine-derived polioviruses (cVDPVs) are associated with sustained person-to-person transmission and considered to be circulating in the environment.

Immunodeficiency related vaccine-derived poliovirus (iVDPVs) are isolated from immunodeficient patients who have prolonged infections after exposure to OPV and this iVDPV has not been observed to transmit or spread to others.¹⁰

Ambiguous vaccine-derived poliovirus (aVDPVs) are isolated from a single immunocompetent AFP or paralytic poliomyelitis patient with or without additional isolates from contacts, or from healthy individuals or the environment in absence of paralytic cases.

RISK FACTORS FOR VDPV EMERGENCE

- Low immunity levels in a population – this is the principal reason.
- Poor routine immunization coverage with OPV. If a population is fully immunized against polio then it will be protected against the spread of both wild and vaccine strains of poliovirus.
- Absence of high quality supplementary immunization activities (SIA) following a AFP case. This is because the virus has time to change, replicate and exchange genetic material with other enteroviruses, while spreading through a population.

MANAGEMENT OF cVDPVs

Management is similar to management of wild poliovirus outbreaks, i.e. by rapid implementation of large-scale, high-quality SIAs by tOPV.

DEFINITION OF ACUTE FLACCID PARALYSIS

Acute flaccid paralysis is defined as sudden onset weakness and floppiness in any part of the body in a child <15 years of age or paralysis in a person of any age, in whom polio is suspected.

Aim of AFP surveillance is to rule out polio infection from as many AFP cases as possible and to test the stool specimens from all AFP cases soon after the onset of paralysis, since sensitivity increases when more AFP cases are investigated.

All cases of acute flaccid paralysis (as per existing case definition) should be reported irrespective of diagnosis within 6 months of onset. Sudden onset means short, brief duration or rapid progression, weakness and floppiness is assessed by paralysis or paresis in technical

terms and flaccidity is meant by floppy or soft and yields to passive stretching at any time during the illness; hypotonia. Each and every case is included with history of

- Current flaccid paralysis
- History of flaccid paralysis in the current illness
- Borderline, ambiguous or doubtful clinical signs

Actions following identification of an AFP case:

All AFP cases are to be reported immediately to DMCHO/SMO over phone. Then stools (Adequate stool) are to be collected within 14 days from onset of paralysis. If it is not possible to collect stool specimens <14 days, specimens should still be collected up to 60 days after onset of paralysis. As more often than not, cases come late, reporting has to be prompt. The house to house campaign approach is the most effective method to find out additional cases. The home of each AFP case should be visited; line listing of all AFP cases should be maintained.

Following an outbreak, all the neighboring health units should be alerted and control immunization activities should be initiated immediately, this is known as Outbreak Response Immunization (ORI). Outbreak control should cover the entire village in rural areas and the municipal ward in urban areas where AFP case occurred. Before initiating immunization, stool specimen as a part of the case investigation should be done first; otherwise vaccine virus may interfere with attempts to isolate the wild virus from these cases. One dose of trivalent OPV is the vaccine of choice for containment vaccination of all under 5 children in that region.

Weekly reports are to be submitted in prescribed format on every Monday. Nil reporting is as important as case reporting. In case with clinical dilemma, over-reporting is better than under-reporting. Both clinical and epidemiological investigation of the case is carried out either by Surveillance Medical Officer or District Immunization Officer or trained medical officer. For documentation, case investigation form (CIF) and laboratory report form (LRF) are filled.

Every AFP case must have a unique case investigation number that can be used to follow-up the case and track stool samples and other information. The AFP case identification number, also called the 'EPID' number is assigned for this purpose. It consists of 13 alphabetic characters and digits. Example: IND – AB – XYZ – 09 – 001. First 3 characters identify country, here IND indicates India. Next 2 characters (AB) identify state, next 3 characters (XYZ) identify district, from where the case has been detected. The next 2 digits identify year of paralysis onset (e.g. 2009) and last 3 digits identify number of the case (001).

Adequate stool sample is meant by 2 samples, each at least 8 gm (adult thumb size), collected within 14 days of onset of paralysis, with minimum 24 to 48 hours interval, reaching an WHO accredited laboratory in good condition (i.e. no leakage, no desiccation, with

proper documentation and maintaining proper reverse cold chain).

SURVEILLANCE INDICATORS

To assess the completeness and sensitivity of surveillance at any point of time two principal indicators have been taken. 1. Non polio AFP rate (background rate), and 2. Adequate sample rate.

Background Rate of AFP

If polio is absent in any area, there will be at least one nonpolio AFP case per year for every 1 lakh under 15 years age group. As per National Polio Surveillance Project (NPSP) views if surveillance is not very bad, then there will be at least two nonpolio AFP cases per year for every 1 lakh under 15 population, i.e. Annualized nonpolio AFP Rate at any time will be at least 2.

Adequate Sample Rate

Percentage of AFP cases with 2 stool samples within 2 weeks after paralysis onset should be at least 80 percent.

RECENT INTERVENTIONS IN ERADICATION

Sequential elimination: Wild Polio Virus type 2 (WPV2) last identified in October 1999, and that has been eradicated from the world. WPV1 and WPV3 are still circulating. WPV1 is more dangerous because it causes more paralysis, spreads more rapidly and to a greater distance and has a lower infection to paralysis ratio - 200:1 vs. 1000:1.

Monovalent vaccines: Monovalent oral polio vaccine (Type1) mOPV1 introduced in 2005 in India is more potent than trivalent vaccine against wild polio vaccine 1¹¹ and being used extensively since 2006 in areas where WPV1 identified in pulse polio immunization campaign. Monovalent oral polio vaccine (Type3) has also been introduced later in areas with WPV3.

The Government of Uttar Pradesh, the National Polio Surveillance Project and the United Nations Children's Fund (UNICEF) implemented a pilot birth-dose project aimed at identifying and vaccinating all newborns with a dose of mOPV1 within 72 hours of birth in an effort to evaluate operational feasibility and potential impact on population immunity. Although the costs were high and impact was estimated as marginal, but this provided opportunities to strengthen newborn tracking systems.⁶

Migratory population round: When a SNID is carried out in Bihar and UP, simultaneously a special round with the same vaccine is carried out in migratory dominated pockets of West Bengal, Gujrat, Maharashtra, and Punjab.

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Worm Infections (Helminthiasis)

Helminths are so called because they possess a "helminth" or body cavity. The helminths are grouped into three zoological classes as trematodes, cestodes and nematodes. The trematodes or flukes are flat and leaf like, with an unsegmented body. The cestodes or tapeworms are flat, long, ribbon like worms with segmented body. The nematodes or roundworms are long worms with a cylindrical body which looks round on cross section. Helminths affect human health in all parts of the world. They differ markedly in their geographical distribution, prevalence rates and pathogenicity. They require special conditions for survival and transmission. Helminths are classified according to the mode of transmission into the following five groups:¹

Snail transmitted: The infective stages develop in snail, either as the only intermediate host or as the first intermediate host followed by further partial development in another intermediate host (e.g. flukes).

Food animal transmitted: The infective stages develop in animals whose flesh is an important item of food for man (e.g. tapeworms).

Contagious or fecal-borne: Eggs or larvae are infective when passed in stools or when deposited at the anus (e.g. enterobius). The infection is thus transmissible directly from person to person.

Soil transmitted (Geohelminths): Eggs or larvae become infective after a period of incubation in soil (e.g. roundworm, whipworm, hookworm and *Strongyloides stercoralis*).

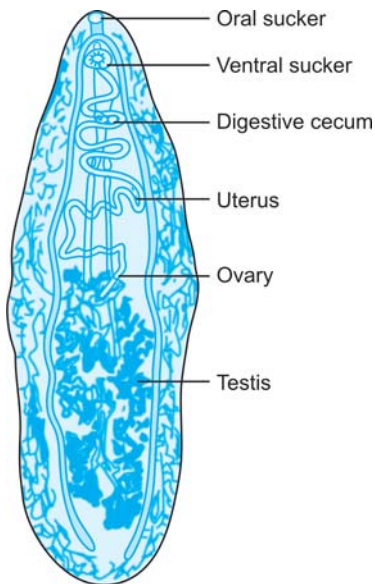


Fig. 17.4: Fluke

Arthropod transmitted: The infective stages develop in arthropod intermediate hosts which transmit the infection when they bite the human beings, or are ingested by them (e.g. filaria and guinea worm).

The prevalence of helminthic infections is an index of the level of sanitation in the community. Prevention of water, food and soil pollution, coupled with personal hygiene, will eliminate all helminths except those that are arthropod-borne.

Snail Transmitted Helminths

These are all trematodes or flukes. These are flat leaf like, pear shaped worms with an unsegmented body, covered outside with a cuticle. Two prominent suckers on the surface give the parasites a perforated appearance. Their habitat may be liver, lung, intestine or circulatory system, but all feed on blood. They are bisexual except the schistosomes, in which the sexes are separate. Lifespan of flukes is very long, about 10 to 30 years (Fig. 17.4).

LIFE CYCLE IN GENERAL

Eggs are passed in stools and rupture on coming in contact with water, releasing a ciliated miracidium or larva. The latter is swallowed by a mollusc (snail), an intermediate host in which it forms a sporocyst. Cell masses called cercariae escape from the sporocyst and leave the body of snail. Cercariae are the infective larvae. While lying on grass or in the body of fish, they are eaten in an encysted stage by man or animal acting as the final or definitive host. The infective larva develops into adult in the intestines, liver or lung of the definitive host. In case of schistosomes (blood flukes) the larvae penetrate the intact skin, enter the blood circulation, lodge in the veins of bladder or rectum and develop into adults.

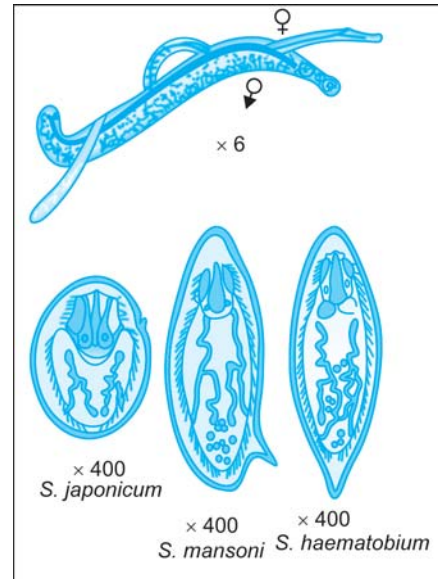


Fig. 17.5: Schistosomes: Adults in embrace and eggs

FAMILY FASCIOLIDAE

Fasciola hepatica: It is found in Middle East and Africa but not in India. It lives in liver and bile passages. Sheep is the most common host. Man is infected very rarely, the symptoms being in the nature of mild intestinal or hepatic disturbances.

Fasciolopsis buski: It lives in the intestine of pig, the reservoir host. Human infection is rare and is found in China and far East. Symptoms occur in the form of diarrhea.

Clonorchis sinensis: It is found in East Bengal and Assam. Infection occurs by eating raw fish. The parasite lodges in the bile passages. The reservoir is cat, rarely man. It may cause cirrhosis, hepatic atrophy, cancer of liver and obstructive jaundice.

Paragonimus westermani: It is a lung fluke for which pig, cat and dog (very rarely man) are the definitive reservoir hosts. Eggs are voided in feces and sputum. When they come in contact with water, miracidia are released and enter snails. Larvae emerge from the snails and enter crabs or crayfish which, on being eaten by man, infect the latter. Symptoms are cough with expectoration and hemoptysis. The eggs are passed in sputum. The lung fluke is found in Korea and China but not in India.

FAMILY SCHISTOSOMIDAE

It consists of blood flukes or schistosomes. The word schistosome means a pair. It is so called because the male and the female remain in perpetual embrace. The male forms a gynecophoric canal in which the females is held all the time except when it goes out to lay eggs (Fig. 17.5). The infection is called schistosomiasis or bilharziasis. Three types of infections occur.

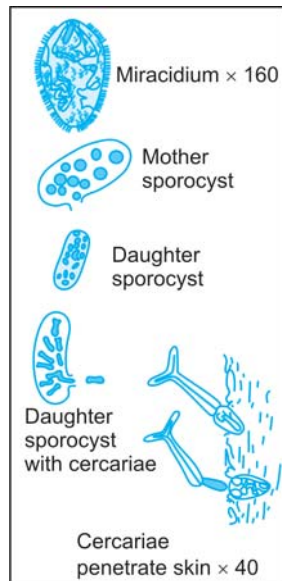


Fig. 17.6: *S. hematobium*: larval stages in water

S. haematobium

Initially a parasite of Nile Valley, it has now spread to other countries also. A focus was found in Ratnagiri district in Maharashtra and the infection was imported to Punjab from the Middle East two decades ago. The snail identified in Ratnagiri focus is *Ferrissia tenuis*. Some monkeys are naturally infected. Rat, mouse and sheep can also get the infection.

Life cycle (Fig. 17.6): The adults lodge in portal, vesical, hemorrhoidal and uterine veins and live for 2 to 5 years. The male is 1.2 cm long and carries the slender female, 2.5 cm long, in a ventral canal called gynecophoric canal. Eggs are 0.16 mm long, oval, with a terminal spine. They are found in urine and occasionally in feces. Eggs are laid in veins and pierce through the small venules to enter the bladder or rectum. They are thus discharged in urine, and occasionally, in stools.

On reaching water the eggs form miracidia. The latter enter the snail and form sporocysts and daughter sporocysts. The tadpole like cercariae with bifid tails that come out enter the body through skin or buccal mucous membrane when a person is taking bath. Then they enter the circulation, lodge in the veins of predilection and develop into adults. It may be mentioned that storage of water for 48 hours before use provides protection against infection (Fig. 17.6). The reason is that the cercariae survive in water only for 24 to 48 hours.

***S. mansoni*:** It is found mainly in Brazil, Puerto Rico and Venezuela. The adult lives in mesenteric vein and the branches of mesenteric and portal veins. The eggs pierce the venules under the mucous membrane of the rectum and are passed out in stools. The eggs have a lateral spine.

***S. japonicum*:** The habitat is same as for *S. mansoni*, but the main hosts are cat, dog, cattle and field mice. The egg has a knob instead of spine. The female produces about 250 eggs per day. Infection is peculiar to East Asia, Japan, China Thailand and Laos. Symptoms appear 4 to 6 weeks after infection. Blood appears in urine or stools due to the ulceration of bladder and rectum in 1 to 3 months. Irritation of bladder and rectum may occur. Liver and spleen are enlarged and severe anemia may be present. Fever, toxemia and skin eruptions are common. Phlebitis of veins due to chronic irritation may result in calcareous deposits in the bladder, chronic vesiculitis, fistulae, papillomatous growth, cancer and secondary hydronephrosis. Hematuria, precipitated on exertion, is a characteristic feature. The clinical features vary in urinary, rectal or visceral schistosomiasis.

Diagnosis is made by detection of eggs in urine and stools. The urine should preferably be collected after exertion. Intradermal and serological tests may be done, especially in old cases.

PREVENTION AND CONTROL OF SCHISTOSOMIASIS

It is important to prevent schistosomal infections from entering India and from gaining foothold here. General control measures include the following:

- Prevention of pollution of water with excreta
- Molluscicides to kill molluscs
- Cercariae may be killed by storage and chlorination
- Mass treatment with schistosomicidal drugs. Praziquantel is the drug of choice for all the 3 species.

Food Animal Transmitted Helminths

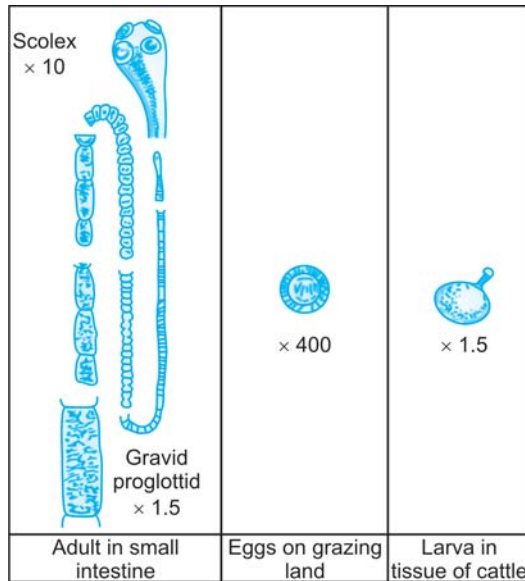
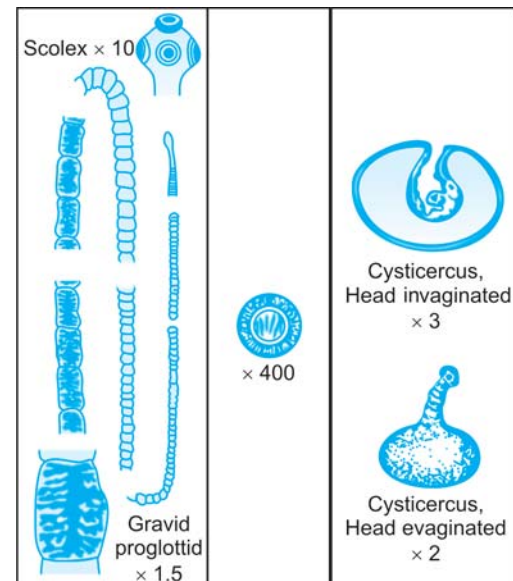
CESTODES OR TAPEWORMS

Tapeworms resemble a ribbon (tenia), hence their name. The adult form is found in the small intestine of carnivorous animals such as man and dog (teniasis). The larval form is found in herbivorous animals such as cattle and the infection in them is called cysticercosis.

LIFE CYCLE IN GENERAL

The adults are attached to the mucous membrane of the small intestine by suckers on the head. They have 3 distinct parts: head, neck, and a segmented body. Each segment is hermaphroditic and produces eggs after copulation with another segment of the same worm or another worm.

Eggs are passed in the stools and are infective. Each egg contains a ciliated spherical embryo known as hexacanth because it has six hooklets. The eggs are swallowed by the intermediate host along with feces or fodder or food. The hexacanth, on coming out of the egg, burrows through the wall of the intestine into

Fig. 17.7: Life cycle of *T. saginata*Fig. 17.8: Life cycle of *T. solium*

submucous blood vessels and goes to the organs of choice, such as liver and muscles. There it loses the cilia and hooklets to form a germinal disk, at one end of which develops the invaginated scolex while the remaining portion gets filled with fluid, giving rise to what is called a cysticercus. This is the larval stage which is swallowed by the definitive host with meat. The scolex evaginates in the intestine of the host and develops into the adult tapeworm. The five species of tapeworms of medical importance are described below.

Taenia saginata (Beef Tapeworm) ICD-B 68.1

The adult worm is 4 to 10 meters long and has about 1000 segments. The head is 2 mm long, bears no hooklets or rostellum and has four elliptical suckers on the sides. The segments are broader than longer. Usually there are less than 4 worms in one host and they live for several years (Fig. 17.7).

The eggs are 30 to 40 microns in diameter. The cysticercus bovis (larval stage of *T. saginata*) is formed in the liver and muscles of cattle. It is 0.5 cm in diameter and is yellowish in color, looking like a split pea. Within the cysticercus is the larva, which can live for about 6 months. Cows get infected by eating human feces or contaminated grass. *T. saginata* infection is rare in Hindus since they do not eat beef.

Diagnosis is done by finding mature segments (proglottids), rarely eggs, in the stools.

Taenia solium (Pork Tapeworm) ICD-B 68.0

T. solium is similar to *T. saginata* except that while the latter causes only enteric infection (adult worm), *T. solium* can also cause somatic infection. Enteric infection by *T. solium* is caused by eating infected pork containing the cysticercus form of the parasite. Somatic infection, manifested by

cysticercosis, is caused when man gets infected either by autoinfection or by ingesting eggs in contaminated food and salad. The last mode explains why many patients of neurocysticercosis are strict vegetarians.^{1a}

T. solium is particularly common along the east coast of India. It is rare in Muslims because they do not eat pork. Life cycle is similar as in case of *T. saginata* except that the intermediate host is pig. The adult is 4 meters long. The head is 1 mm in diameter and possesses a short rostellum, two rows of hooklets and four suckers. It is usually found singly, though rarely 25 to 30 worms may be found in a person. The adult lives for many years. The eggs passed in the stools are eaten by pigs, in whom they form cysticercus *cellulosae* (Fig. 17.8). He then develops cysticercus in brain, eye muscles and subcutaneous tissues (cysticercosis).

Cysticercosis is a more important problem than teniasis as such.^{1b} In man, cysticercosis can manifest in brain, spinal cord, eye, muscles and subcutaneous tissues. Neurocysticercosis is an important manifestation. In a recent series of 317 cases of neurocysticercosis, 70 percent presented with epilepsy and 20 percent with increased intracranial pressure. It tends to be common in north India, may be because of a higher preference to consume salad and raw foods in the north. Neurocysticercosis is currently responsible for 0.4 percent of all pediatric admissions and 2.5 percent of all space occupying lesions at the All India Institute of Medical Sciences.^{1a} More cases are being diagnosed now with the help of CT and MRI. Treatment is based upon use of praziquantel and albendazole, with other supportive and symptomatic drugs like steroids and antiepileptics.

Diagnosis is made by finding proglottids and eggs in the stools. The proglottids disintegrate soon and hence may not be seen. Calcified cysts may be seen in the X-ray. Eosinophilia may be present.

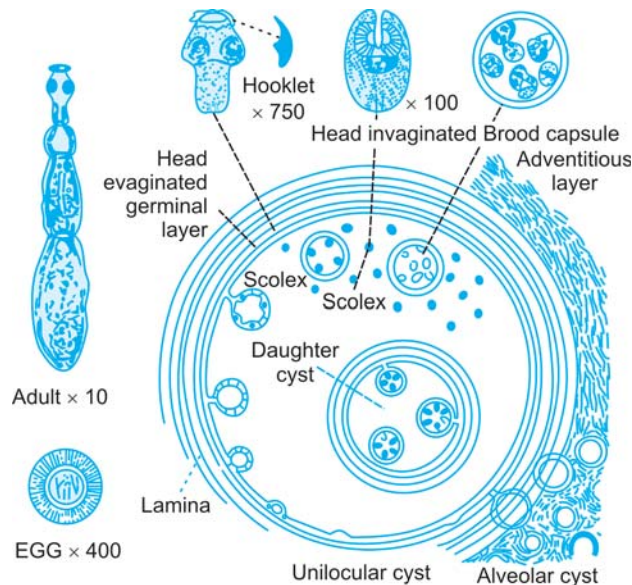


Fig. 17.9: Life cycle of *T. echinococcus*

PREVENTION AND CONTROL OF *T. SAGINATA* AND *T. SOLIUM*

- Regular inspection of meat. Infested beef or pork (“measly pork”) should be discarded.
- Prolonged cooking of meat. Raw meat should be avoided.
- Cattle should not be allowed to eat human excreta or contaminated grass.
- Proper disposal of human excreta.
- Treatment of all cases with niclosamide as the drug of choice. Praziquantel has been recently found to be very effective. If these drugs are not available, mepacrine can be used.

Echinococcus granulosus (Dog Tapeworm) ICD-B 67.4

Dog is the natural definitive host. The adult worm is only 4 mm long and lives in dog intestine. It has only 4 to 5 segments. The last segment is big and gravid and is about 2 mm long.

The head has a rostellum with 2 rows of hooklets and 4 suckers as in case of *T. solium*. The whole worm looks like a wheat grain (Fig. 17.9). Eggs are passed in the stools of the dog and contaminate grass, which is eaten by sheep, the intermediate host. The hydatid cyst or cysticercus is formed in the liver and muscles of sheep. It is also found in cattle, deer, horse and zebra. The dog gets infected by eating the cysticercus in sheep meat. The larval stage within the cysticercus grows into adult worm and the cycle is thus completed. Man is an accidental intermediate host. He is infected through vegetables or food contaminated with infected dog’s excreta. Dog lovers and shepherds may contaminate their fingers while handling the dog and may thus get infected. Human infection is more common in sheep

raising countries such as Australia, New Zealand, Middle East, Turkey, etc.^{1c} In India it is particularly common in Tamil Nadu and Andhra Pradesh.^{1d}

Hydatid cyst: The ingested eggs hatch in man’s intestine, liberating larvae. The latter lodge in liver (67%), spleen (1.3%), kidneys (3%), brain, bones, joints and muscles. There the larva changes into a cellular mass called morula which develops fluid in it, forming a cyst. It has two layers, an outer fibrous layer called ectocyst and an inner germinal layer called endocyst. A number of secondary and tertiary morulas with fluid are formed from the germinal layer, known as daughter and granddaughter cysts. The smallest cysts inside the endocyst are called brood capsules in which a number of invaginated headends or scolices are formed. Sometimes, a part of germinal layer pushes out of the ectocyst and produces a new cyst called exogenous cyst. Free bits of germinal layer may fall out on the pleura or peritoneum to form implantation cysts. Cysts may be unilocular or multilocular. Some may get calcified. It is obvious that the hydatid is a very complicated cyst.

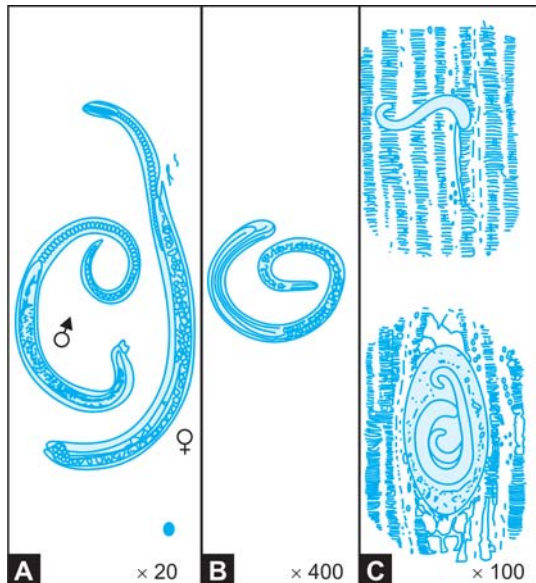
Diagnosis of the cyst is made by X-rays. Puncture of cyst should be avoided to prevent infection of other organs. Casoni’s skin hypersensitivity test may be done with the antigen prepared from cyst fluid. Pet dogs should be regularly treated with a vermifuge as a prophylactic measure. It is important to wash hands after patting a dog in order to avoid infection. It is best not to eat raw vegetables.

Diphyllobothrium latum (Fish Tapeworm)

It is not found in India. Man is the definitive host, while cylops and fish form the intermediate hosts. One should not eat raw fish in order to avoid infection.

Trichinella spiralis

It is an intestinal roundworm found in several mammals, especially canines, pig and rat. Animals get infected by eating flesh of infected animals containing larvae encysted in muscle and other tissues (Figs 17.10A to C). In the intestine, the larvae are released. They penetrate the lymphatics, enter the blood stream and are disseminated to all parts of the body, especially the striped muscles. The organs most commonly involved are diaphragm, ribs, larynx, tongue and eye, i.e. the muscles which are very active and rich in glycogen. Cardiac muscle may also be involved. The larva coils up in the muscle fibers into loose spirals, hence the name. It grows from 0.1 to 1 mm, gets encysted and does not develop further. When the flesh is eaten by another animal, the encysted larvae are liberated and develop into adults in the intestinal mucosa within three days. The cycle ends in the man for obvious reasons. The reservoirs of infection are pigs, dogs, cats, rats and



Figs 17.10A to C: Life cycle of *Trichinella spiralis*: (A) Adult worm (paralia (3 mm female 3 to 6 mm); (B) Larva, before reaching tissues (0.1 mm size); (C) Larva in muscle before and after encystment

many wild animals such as fox, wolf, etc. Almost 75 percent rats living near the slaughter houses are infected.

Man gets infected by eating undercooked or uncooked or uncooked pork in which the cysts can be seen as chalky deposits. The disease is obviously rare in those who do not eat pork, especially Muslims and Jews. Necropsy surveys in USA in the 1950's revealed a prevalence rate of 16.7 percent. This has now fallen to 2 percent or less 2 percent.²

Clinical picture depends upon the intensity of infection. When the number of larvae ingested is small, there may be no or few symptoms. Heavier infection can cause immediate symptoms like nausea and vomiting 24 to 48 hours after the infected meal. These are due to intraintestinal activity of adult worms. Late symptoms occur 1 to 6 weeks later. These are due to larval invasion of body tissues. Characteristic and early symptoms are muscular pain and soreness along with edema of upper eyelids. Fever may be present. Severe infection may be accompanied by muscular, cardiac and neurological symptoms. Fatal infections can occur.

Diagnosis depend upon eosinophilia, serological tests and demonstration of encysted larvae in muscle biopsy. The biopsy should be done not earlier than 10 days after exposure to infection. The larvae live in the tissues for 6 months. They get calcified in 2 years.

Control measures: Rats should be eliminated from slaughter houses and meat markets. Regular meat inspection should be carried out. Infested meat, called measly pork, should be discarded. The discarded meat should be destroyed and not fed to hogs or other animals.

Contagious or Fecal-borne Helminths

These include one cestode *H. nana* and one nematode (*Enterobius*).

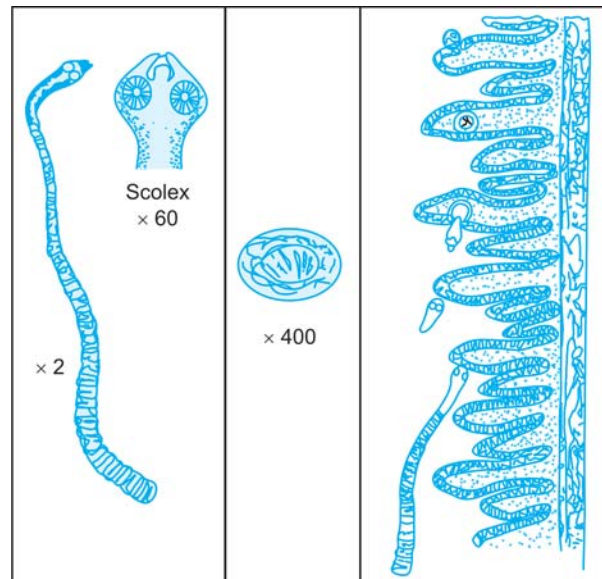


Fig. 17.11: Life cycle of *H. nana*

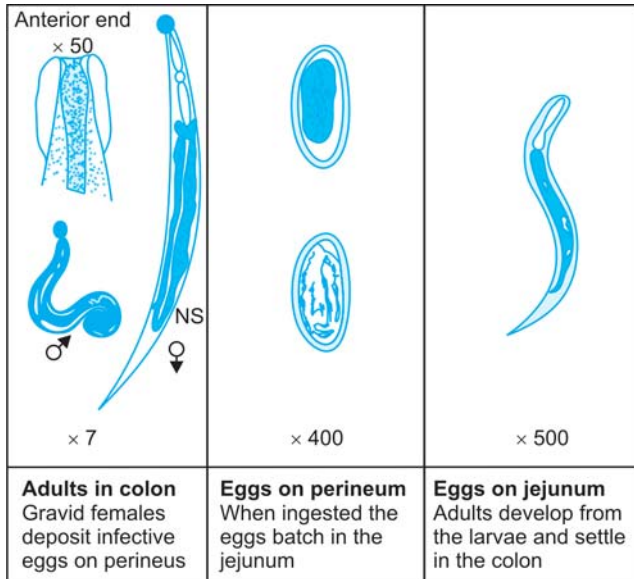
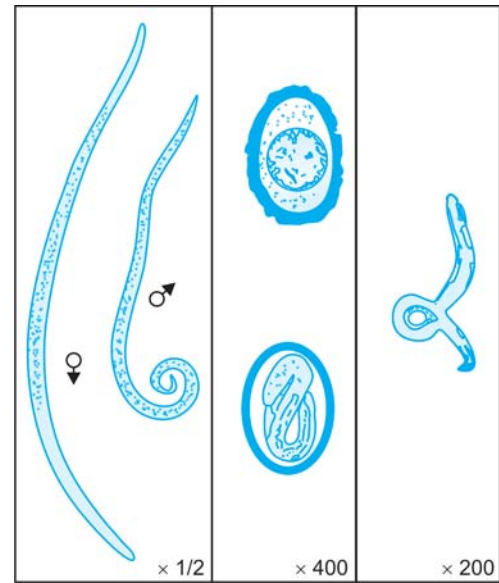
HYMENOLEPSIS NANA

It is cosmopolitan in distribution. The prevalence rate in children in the tropics is 5 to 10 percent. Infection occurs from man to man, there being no intermediate host. The adult worm is 1 to 3 mm long and 0.55 mm broad and resides in the intestine. The head has a retractile rostellum with 24 hocklets. Thousands of worms may be found in the intestine at a time but the lifespan is short. Immunity develops soon, hence infection is rare in adults (**Fig. 17.11**).

Diagnosis is made by finding the characteristic two knobbed eggs in the stools. The drugs of choice in niclosamide. Paromomycin may also be effective. If they are not available, mebendazole, mepacrine or chloroquine may be used.

ENTEROBIUS VERMICULARIS

This worm is commonly known as threadworm or pinworm. The infection, called enterobiasis or oxyuriasis, is found worldwide and is more common in children. The eggs are 40 to 50 microns long and 20 to 25 microns broad and are planoconvex in shape. They have a thick, clear, double walled shell. The eggs are rarely seen in stools. The female comes out of the anus onto the perineum of the host to lay eggs. This process causes irritation and itching, causing an urge to scratch the perineum. The larva develops within a few hours of egg laying. After the eggs are swallowed, the larvae are liberated in the small intestine and develop into adults in about ten days. The adult female is one cm long with a thick anterior end like a pin head, tapering at the back. The male is a quarter cm long and dies after copulation. It is, therefore, seldom seen except in autopsies. The lifespan of the adult is 2 to 4 weeks. The whole life cycle require 3 to 6 weeks (**Fig. 17.12**).

Fig. 17.12: Life cycle of *E. vermicularis*Fig. 17.13: Life cycle of *A. lumbricoides*

MODE OF TRANSMISSION

It is of two types:

1. The child scratches the perineum because of irritation and his nails become infected with eggs, leading to infection of others through fecal-oral route as also to autoinfection. Thus infection with threadworm may persist for years.
2. Dust-borne infection may occur in heavily infected households and institutions for children.²
After coming out of the anus, the worm may enter the genital tract in women, leading to peritonitis.

Control measures: Nails should be kept short and clean. Hands should be washed before meals and after going to toilet. All members of the family should be treated at the same time. Pyrvinium pamoate, pyrantel pamoate, mebendazole and piperazine are effective drugs.

Soil-transmitted Helminths

These helminths have a wide distribution and high prevalence. Their infective stages develop in the soil. The group includes ascaris, whipworm, hookworm and strongyloides.

ASCARIS LUMBRICOIDES (ICD-B77.9)

It is the most common intestinal parasite of man. Possibly one out of every 4 people in the world is infected.³ The worm is found in any area of the world where there is no proper disposal of nightsoil.

LIFE CYCLE

The adult worm is round and cylindrical in shape and lives in upper portion of the small intestine. The male

is 10 to 12 cm and female 15 to 30 cm long. One female worm passes 2,00,000 eggs per day, sufficient for stools to be positive. The eggs are 60 to 90 microns in diameter and elliptical in shape. They have a rough surface and fimbriated or wavy outline and are unsegmented. The embryo or larva develops inside the egg in moist earth in 10 to 40 days. These embryonated eggs can remain viable in soil for many years under favorable conditions. The embryonated eggs are ingested along with infected food or soil. The larvae are released in the intestine, pierce the intestinal wall, enter portal circulation and reach the lungs, passing from pulmonary capillaries to air sacs and, thence, to bronchi, trachea, esophagus and small intestine. Fatal pneumonia may sometimes occur if very large number of larvae are present in the alveoli. On reaching the intestine the larvae develop into adults (Fig. 17.13).

Biological incubation period, from passage of eggs in stools to the development of adults in the intestine, is 2 to 3 months.

CLINICAL FEATURES

There are no specific symptoms. Urticaria and eosinophilia may occur as a manifestation of allergy to larvae and adults. Ascaris infection contributes to malnutrition in children.⁴⁻⁶ In areas with high prevalence of ascariasis, roundworm induced intestinal obstruction is the more common cause of laparotomy in children. It has been reported to be the more common cause of biliary disease in Kashmir.⁷

Children, especially preschoolers, are infected more than infants and older children. The incidence falls after 15 years of age. Insanitary habits, poor food hygiene and repeated infection of soil and water by human excreta are factors favoring spread.

CONTROL MEASURES

In general, three approaches to ascariasis control have proved valuable:

1. Treatment of the infected population by piperazine, pyrantel or mebendazole.
2. Measures to prevent environmental contamination with human feces.
3. Education of the public in personal hygiene. In the most successful programs, all three measures have been undertaken simultaneously. A unique example of successful control is Japan, where the prevalence has decreased from 70 percent in 1950 to 0.09 percent in 1979.⁸

TRICHURIS TRICHIURA (WHIPWORM)

Trichuriasis is prevalent worldwide and, like roundworm and hookworm, infects nearly one-fourth of the world population. As in case of ascaris, the eggs are passed in stools, become infective in 3 to 4 weeks as the larva develops, and are swallowed with soil, polluted water, food or vegetables or through soiled fingers. On reaching the intestine, the larva is liberated from the egg and develops into an adult worm in about a week's time. The worm is 3 to 4 cm long and looks like a whip, with a coiled handle and a thread. It is partly embedded in the mucous membrane and intestine (**Fig. 17.14**). The worm is usually nonpathogenic. Massive infections may be associated with gastrointestinal symptoms. Mebendazole is the drug of choice.

Hookworm (ICD-B76.9)

Uncinariasis or hookworm infection is largely caused by *Ankylostoma duodenale* in India. *Necator americanus*

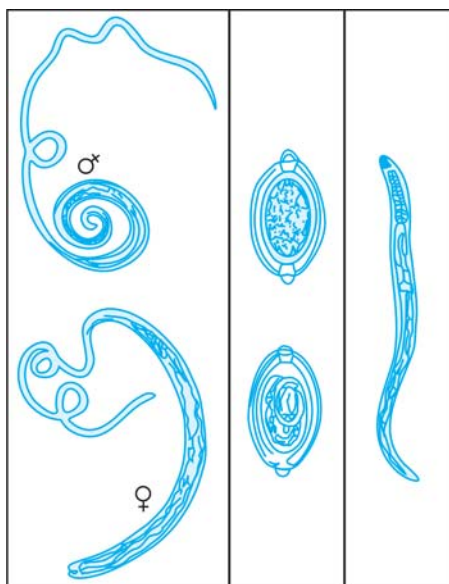


Fig. 17.14: Life cycle of *Trichuris trichiura*

infection is common in South India. A third species, *A. ceylanicum*, has been reported in Bengal.⁹ The worms are attached to intestines and cause gastrointestinal symptoms like distension and epigastric discomfort. Progressive anemia of hypochromic microcytic type due to sucking of blood by worms is the more common symptom. The tendency for anemia is exacerbated by the fact that the worms keep on shifting in the intestine, leaving behind bleeding points or open wounds. It has been estimated that daily blood loss in world population due to hookworm is equivalent to total exsanguination of about 175 million people. Most workers believe that presence of more than 500 worms is necessary to produce anemia.

Occurrence

Hookworm is a curse of the tropical countries 35°N to 30°S of equator. One-fourth of the world population harbours hookworms. It is present in all states in India, the prevalence varying in different districts depending upon soil, moisture and humidity. Soils that retain moisture are very suitable. Dry, hot and saline lands are unfavourable.

LIFE CYCLE

The adult worms attach themselves to the mucous membrane of the small intestine. They are most common in jejunum, less so in duodenum and rare in ileum. The male female ratio is 1:3. Their size is 10 × 4 mm and 15 × 6 mm respectively. The eggs are 70 to 90 × 40 to 60 microns in size. They are characteristically segmented. A rhabditiform larva comes out of the egg in 24 to 48 hours under favorable soil conditions. In another 2 to 5 days, it develops into filariform or infective larva which is thinner and longer and can survive in soil for year. Its usual life is 3 weeks to 2 years. It dies in dry soil and sun but lives long in the shade (**Fig. 17.15**). The filariform larva in soil enters the bare skin of feet, legs or, sometimes hands. It may cause local itch known as ground itch. It enters the lymphatics and the blood stream, reaches the lung capillaries and pierces into the air sacs of lungs. From there it goes to bronchi, trachea and oropharynx, gets swallowed and reaches the stomach. The larvae develop into adults in the intestine. The life of the adult worm is uncertain but long. Frequently, reinfection maintains the infestation. Infection may sometimes occur by oral route when infected larvae are ingested with polluted water, vegetables or food and pierce through the mucous membrane of the intestine to complete the biological cycle.² Eggs appear in stools 6 to 7 weeks after infection.

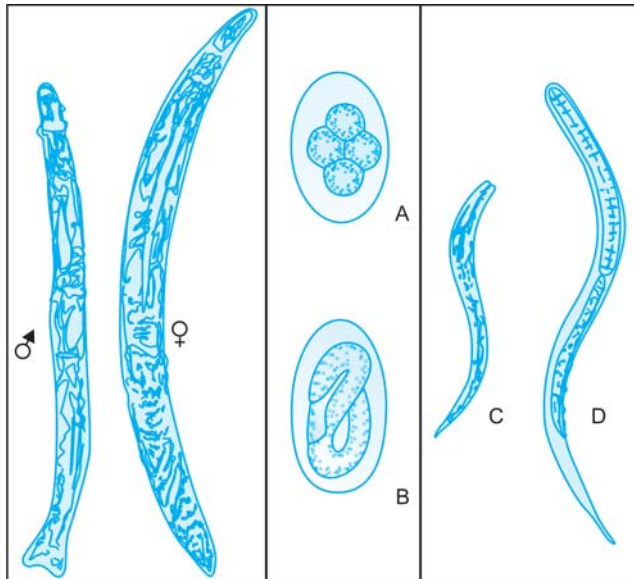


Fig. 17.15: Life cycle of *A. duodenale*

CONTROL MEASURES

There includes the use of latrines and sanitary disposal of excreta so as to prevent soil pollution. People in endemic zones should wear shoes and should not wash hands with earth. Health education is of obvious importance. Mass treatment with mebendazole or pyrantel pamoate may be undertaken in areas with high prevalence.

STRONGYLOIDES STERCORALIS (ICD-B78.9)

Its distribution is similar to hookworm but is more patchy. It is particularly prevalent in some parts of Africa and South America and in West Bengal in India. The adult, a parthenogenetic female, remains embedded in the wall of the small intestine, especially the duodenum, where the eggs are deposited. They hatch to produce rhabditiform larvae which pass out in the stools and develop into infective filariform larvae in the soil after 3 to 4 days. They penetrate the skin of feet and hands, enter the capillaries, reach the lungs and ultimately lodge in the intestine. Autoinfection sometimes occurs when rhabditiform larvae develop into filariform larvae in the intestine itself. They penetrate the bowel mucosa or perineal skin to enter the same host, causing massive infection. Symptoms may be in the nature of vague gastrointestinal disturbances. Mebendazole provides effective cure.

Arthropod Transmitted Helminths

These include guinea worm (a tissue roundworm) and microfilaria (blood roundworms). Only the former will

be discussed here. Filariasis is described in detail in Chapter 19.

DRACUNCULUS MEDINENSIS (GUINEA WORM)

Guinea worm is a tissue roundworm. The infection with this worm is called dracontiasis. It occurs in those villages where water supply is from stepwells, tanks or ponds. There has been a natural decline in incidence of this disease in India during the last 25 years.

LIFE CYCLE AND MODE OF SPREAD

The female worm is thread-like, about 0.4 mm thick and about one meter long. The male dies after copulation in the intestine. The female worm then passes through connective tissues and makes its way to the skin of hanging parts such as leg, foot, breast and testes. It may be seen as a wavy band under the skin. A blister develops on the skin and the uterine end of the worm appears in the blister, most often on the skin of foot. The patient gets a soothing feeling when the blister is dipped in water. When the patients puts his foot in the stepwell or tank water, the blister, along with the uterus containing the larvae, bursts and the larvae escape into the water. The latter may survive in water up to 16 weeks. If there are cyclops (water flea) in the water, the larvae are swallowed by them. The cyclop acts as an intermediate host and is swallowed by man along with water. The cyclop is digested and the infective larva is liberated in the stomach. It passes into the intestine where it develops into adult male or female, thus completing the life cycle or biological incubation period. The total cycle takes about one year.

OCCURRENCE

Guinea worm is well on its way to global eradication. Only nine cases were reported in India in 1996. These were from 3 villages of Rajasthan. An independent international evaluation team certified in December 1995 that disease transmission has been probably interrupted completely and no new case is likely to arise.¹⁰ During 1997 and 1998, not a single case of guinea worm has been reported in India. The Sixth Independent Evaluation Program conducted in January 1998 has validated the reported zero guinea worm status in India and absence of disease transmission.¹¹ The International Commission for Certification of guinea worm investigated the situation in 62 villages recently. Based on this, the WHO has certified in **February, 2000** that guinea worm infection has been eradicated from India.

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These are also referred to as surface infections. Common factors in their epidemiology are direct or indirect contact and low hygienic standards. Direct contact implies that the skin or mucous membrane of a healthy person comes in contact with the sufferer or carrier of the infection through means such as touching, rubbing, kissing or having sexual intercourse. Indirect contact is brought about through fomites like clothes, shaving brushes, towels, fingers and kajal sticks.

Because of direct contact, the contact diseases are also called contagious diseases. However, this term is not very appropriate since it also includes droplet infections like diphtheria, influenza and whooping cough contracted by sitting face to face but not in actual contact of skin or mucous membrane. It may, however, be mentioned that droplet infection has also been suggested lately as a possible mode of spread of leprosy. In case of contact diseases, the contagion or infection comes out of the skin or mucous membrane of the infected person and enters through the skin or mucous membrane of the healthy person.

Classification of the diseases in this group has been given in Chapter 15. The main diseases described here will be Leprosy, Sexually transmitted diseases, Trachoma, Ringworm and Yaws.

Leprosy (ICD-A30.9)

Leprosy continues to be a social and public health problem but the situation is gradually improving.

History and Prevalence

It is a disease of antiquity. Sushruta Samhita described the disease and its treatment in 600 BC. The causative organism, *Mycobacterium leprae* was discovered in 1873 by Hansen of Norway. Sulphone drugs were introduced for treatment of leprosy in 1943.

As in March, 1998, there were 5.03 lakh leprosy cases in India.¹ This is a marked decline from 4 million cases in 1981. India accounts at present for 75 percent of total leprosy cases in the world.^{1a} 62 percent cases in India come from five states, namely West Bengal, Orissa, Bihar, MP and UP.¹ The overall prevalence in

India in March 1998 was estimated to be 5.3 per 10,000 compared to 57 per 10,000 in 1981. About 15 to 20 percent patients are children. The proportion of multibacillary cases is 42 percent among total cases and 30 percent among new cases. The deformity rate is 6 to 8 percent and 3.9 percent among total and new cases respectively. 20 percent of the leprosy patients at present are of infectious type.¹ For the first time in 1997 to 98, the newly detected cases were less than the discharged cases, the number being 5.2 lakh and 5.5 lakh respectively.¹

Epidemiology

Prepathogenesis (agent, host and environment factors), pathogenesis and prevention and control of leprosy are described below in detail.

AGENT FACTORS

The causative agent, *Mycobacterium leprae* is a gram positive, acid fast bacillus that is rapidly decolourised by alcohol. The leprosy bacillus is a very hardy organism. It needs more than two hours exposure to direct sunlight to kill the bacilli. In hot, humid conditions, the bacilli have been shown to remain viable for about 1½ months, may be even for a greater period.

Source of Infection

Open cases of lepromatous leprosy constitute the principal source of infection. Microorganisms escape from broken nodules and the secretions from mouth, nose and pharynx. An untreated lepromatous leprosy patient may pass 100 million bacilli per day in the nasal secretions.^{1b} Recent evidence suggests that apart from man, certain wild animals, e.g. armadillos, mangabey monkeys and chimpanzees may also suffer from leprosy infection.

Mode of Entry

Prolonged and intimate contact was earlier considered essential to get leprosy infection. It is now believed that such contact is important but not essential. The majority of patients do not give any history of contact with a patient of leprosy. Children are often in intimate and

prolonged contact with leprosy patients, but only a few get the disease. Once the infection takes root, overcrowding and contact may facilitate further spread in the family. The infected persons discharge bacilli through nasal mucosa, ulcerated lesions, broken skin, etc.

Microlesions are often found in the nasal mucosa of healthy contacts of leprosy patients. Entry through skin and gastrointestinal tract (in case of babies whose mothers are discharging *M. leprae* in breast milk) is also possible. Bacilli from dried nasal secretions remain viable in shade for 24 hours and sometimes for seven days or even more. Transmission by indirect contact may also be important.² *Droplet infection* is perhaps a common mode of transmission, the most important portal of entry (as also of exit) for leprosy being the nose. *Contact transmission* is also of importance. Indirect contact (through soil or fomites such as clothes, linen) is perhaps more important than direct skin to skin contact. Other modes of transmission include breast milk, insect vectors and tattooing needles. These are not of much public health importance.

Pathogenicity and virulence seem to be low because the incubation period is very long (3–5 years) and the disease process is very slow. This is partly attributable to the long generation time of 12 to 13 days for *M. leprae*, the longest known for any bacterium.

HOST FACTORS

Age

The age at which leprosy is contracted depends primarily upon opportunities for exposure to infection. If there is contact with an open case, all ages are equally vulnerable.

Sex

Sex ratio of males to females for all types of leprosy is 3:2. In case of lepromatous type, it is 3:1. Only slight or little sex difference is seen in childhood.

Race and Caste

Higher incidence of leprosy is seen in some hilly, tribal and other isolated communities. The proportion of lepromatous cases is 5 percent in Africa, 15 percent in India, 30 percent in Mongolian races and 50 percent in Caucasians in the cold and temperate regions. This difference is probably a racial characteristic related to pigmentation of skin.³

Heredity

Susceptibility to tuberculoid leprosy is probably related to HLA types. There is some evidence that the occurrence of lepromatous leprosy depends upon a host determined characteristic present in a small number of people.^{1b} There is also evidence that a change is

occurring in the endemicity pattern of leprosy. While the overall prevalence rate of leprosy remains high, the prevalence of lepromatous cases and the ratio of lepromatous to total leprosy cases are coming down. This suggests that persons susceptible to lepromatous or other low resistance types of leprosy are slowly being eliminated, leaving behind a resistant stock that is more prone to develop the tuberculoid and other milder forms.⁴ It may be mentioned that monozygotic twins have showed more concordance than heterozygotic twins, confirming the role of genetic factors.

Resistance to Infection

Reactivity to lepromin, which is associated with resistance, increases rapidly with age. It is negative in infancy and almost always positive after adolescence in the endemic areas. BCG vaccination has been shown to induce lepromin reactivity in a varying proportion of cases in different trials.

Resistance to leprosy infection can be assessed by tests for cell mediated immunity (CMI) and humoral immunity. These are described below. The most widely used is the lepromin test.

Lepromin test: This detects cell mediated immunity. Lepromin positivity is associated with resistance to leprosy infection. Unlike tuberculin test, it does not indicate present or past infection. Lepromin is a standardized, autoclaved suspension of *M. leprae* extracted from lepromatous tissue of man or armadillo. Three types of antigens are used.

- Mitsuda's crude antigen containing tissue particles and liquids in addition to lepra bacilli (160 million bacilli per ml).
- Dharmendra's purified antigen which is a 'defatted' bacillary suspension (10 million/ml).
- A more recent preparation from armadillo with a specific soluble antigen capable of producing early reaction only.

Of the above, the first two are referred as Lepromin H and the third as Lepromin A. An intradermal injection of 0.1 ml is given for the lepromin test. Two types of reactions are seen. The early (Fernandez) reaction is similar to tuberculin test and is read at 48 hours. It usually tends to disappear after 3 or 4 days. The late (Mitsuda) reaction is read at 21 days and gives an accurate assessment of the cell mediated immunity (CMI). The early reaction comprises of redness and induration and is regarded as positive if the area of redness is more than 10 mm at 48 hours. Early reaction is more marked with Dharmendra antigen, while the Mitsuda antigen is associated with a more pronounced late reaction. Using Dharmendra antigen, the early reaction may be labelled as weak and strong or one plus positive (10 to 14.9 mm), moderately or two plus positive (15 to 19.9 mm) and strong or three plus positive (20 mm and above).

The late reaction consists of a papule or nodule which is first measured after 2 weeks and then at weakly intervals. The reaction is positive in the case of Dharmendra antigen if the size of the nodule is at least 3 mm in diameter. The maximum size is usually attained in the fourth week.

The lepromin reaction essentially tests the cell mediated immunity, which is associated with the ability to digest intracellular bacilli. It is negative in lepromatous leprosy and usually positive in the tuberculoid type. The positivity rate increases with age, tubercular infection, BCG vaccination and exposure to other mycobacteria. The test is hence only of prognostic, not diagnostic value. It is usually positive in almost all adults. The early and late reactions give similar type of information. Most children are lepromin negative up to six months of age. In endemic areas, 20 percent of children below 5 years are lepromin positive, increasing to 60 percent at 10 to 14 years 80 percent at 19 years.

Other tests for cell mediated immunity have become available during recent years. Examples are the lymphocyte transformation test (LTT) and the leucocyte migration inhibition test (LMIT). However, these are only research tools and cannot be used on a mass scale. A specific delayed type hypersensitivity skin test, read at 48 hours, is being developed by the IMMLEPP (Immunology of Leprosy Committee of the WHO). This test is based upon the use of a cell wall free extract of sonicated *M. leprae* derived from armadillo and standardised for protein content.

Serological tests for humoral immunity are as follows:

- **FLA-ABS test:** The Fluorescent Leprosy Antibody Absorption Test is used to detect subclinical infection. FLA-ABS test is 92.3 percent sensitive and 100 percent specific for detecting *M. leprae* antibodies in all types of leprosy regardless of the type and duration of infection.
- Recent advances in immunology have led to development of monoclonal antibodies against *M. leprae* antigens. An *antibody competition test* using monoclonal antibodies has been developed and found to be sensitive.
- **RIA and ELISA:** Radioimmunoassay and ELISA test on phenolic glycolipid antigen (PGL) have also been developed and found sensitive to detect leprosy antigens.

Lepromin test in combination with the FLA-ABS test is now increasingly used in epidemiological studies to identify healthy persons at risk of developing serious forms of the disease.

ENVIRONMENTAL FACTORS

Physical Environment

The disease is found more in the tropics. Large family size and dwellings, especially in urban slums, increase the chances of contact and transmission due to overcrowding.

Social Environment

Contact with persons suffering from leprosy is likely to be more among the poor and the ignorant. Children of parents suffering from leprosy are more exposed to the disease. Deep rooted prejudices lead to social ostracism of patients with leprosy. Thus there is delay in seeking treatment, thereby increasing the possibility of transmission.

Biological Environment

There is no known animal reservoir, but naturally occurring infection in a captive chimpanzee has been reported, and wild armadillos in a limited area of the USA have been found to be infected.⁵

Pathogenesis and Classification

Leprosy is a disease of skin and nerves. Whatever the portal of entry, the target organ for the invading *M. leprae* is probably the endoneurium. The classification of leprosy⁵⁻⁷ is given below. This classification corresponds to the immunoresistance level of the patient and the various types can be easily characterised clinically.

INDETERMINATE LEPROSY

These are usually child contacts who develop a single (rarely 2 or 3) hypopigmented macules which may develop hypoesthesia and decreased sweating. The lesions are usually self-limiting, fading away after some months. However, about one-fourth of the lesions may develop into one of the determinate types.

DETERMINATE LEPROSY

Indian classification (1981): It was proposed by the Hind Kushth Nivaran Sangh. It is a clinicobacterial classification and is used widely in India. The following five types of leprosy are recognised:

1. Indeterminate type
2. Tuberculoid type
3. Borderline type
4. Lepromatous type and
5. Pure neuritic type.

Madrid classification (1959): It is similar to the Indian classification except that it does not have pure neuritic type as a distinct variety.

Ridley-Jopling classification (1966): It is immunohistological in nature and can be used only when full research facilities are available. It has the following five types listed in order of decreasing host resistance:

1. Tuberculoid (TT)
2. Borderline tuberculoid (BT)
3. Borderline (BB)

4. Borderline lepromatous (BL)
5. Lepromatous (LL).

Of the above, the three intermediate groups (BT, BB and BL) are relatively unstable. They tend to progress toward the lepromatous type in the absence of treatment and toward tuberculoid type if effective treatment is initiated.

In the National Leprosy Eradication Program, the classification is done according to whether leprosy is of multibacillary or paucibacillary type. It is worthwhile knowing which stages of the other classifications correspond to these types. This is shown in **Table 18.1**.

Criteria for diagnosis of leprosy are given in **Table 18.2**.

The details of nerve palpation in leprosy are given in **Table 18.3**.

Prevention and Control

Treatment with sulphones and other antileprosy drugs forms the sheet-anchor of prevention and control at individual as well as community level. All steps must, therefore, be taken to bring as many cases as possible under treatment. Currently the multidrug regimen is advocated in India for the treatment of leprosy. The elements of leprosy control are broadly grouped as follows:

- Medical measures
- Social measures
- Managerial aspects
- Evaluation.

MEDICAL MEASURES

General Assessment

The medical measures start with *estimation* of the extent of the disease. This is done in the community by means of random surveys to give information on the age and sex prevalence, types of disease found and the health facilities available. These estimates are essential to plan, implement and evaluate the strategies necessary for the control program.

TABLE 18.1: Classifications of leprosy

NLEP classification	Ridley and Jopling	Indian	International (Madrid)
Paucibacillary	Indeterminate	Indeterminate	Indeterminate
	TT	Tuberculoid	Tuberculoid
Multibacillary	BT	Pure neuritic	
	BB	Borderline lepromatous	Borderline
	BL	Lepromatous	Lepromatous
	LL		

TABLE 18.3: Nerve palpation in leprosy

Nerve	Hints for palpation
Ulnar nerve	Palpation immediately above the ulnar groove
Cutaneous branch of radial nerve	Palpation at the lateral border of the radius proximal to the wrist joint
Median nerve	Deep palpation above or below the antecubital fossa medial to the brachial artery and/or in front of the wrist between the tendons of the palmaris longus and the flexor carpi radialis
Radial nerve	Deep palpation of the radial groove on the humerus posterior to the deltoid insertion
Lateral popliteal nerve	Palpation around the knee to feel the nerve in the popliteal fossa just medial to the biceps femoris tendon, and as it passes around the neck of the fibula
Posterior tibial nerve	Palpation of the nerve posterior and inferior to the medial malleolus
Anterior tibial nerve	Palpation of the nerve as it emerges from under the flexor retinaculum lateral to the tendon of the extensor hallucis longus
Great auricular nerve	Palpation after turning the head to one side, thus stretching the nerve across the sternomastoid
Supraorbital nerve	Palpation by running the index finger across the forehead from the midline laterally

Note: Of the above, examination of ulnar and lateral popliteal nerves is most important (**Fig. 18.1**).

Case Detection

This is an important step in the control program. The objective is to identify and register all cases of leprosy. The strategies adopted include the following:

- *Contact survey* examination of all household contacts, particularly children, of known cases of leprosy in areas with prevalence less than 1 per 1000.
- *Group survey* of preschool and school children, slum dwellers, residents colonies, military recruits and workers in industries through 'skin camps' in areas where prevalence is more than 1 per 1000.

TABLE 18.2: Cardinal features of leprosy

<ul style="list-style-type: none"> • Hypopigmented or reddish skin lesion(s) with definite loss of sensation. • Involvement of the peripheral nerves, as demonstrated by definite thickening with loss of sensation and weakness of the muscles of the hands, feet or face. • Demonstration of <i>M. leprae</i> in the lesions. <p><i>The first two cardinal signs can be identified by clinical examination alone while the third can be identified by examination of the sliik skin smear.</i></p>

Note: At least one of the above three must be present for diagnosis of leprosy.^{1a}

- *Mass survey* in areas of very high prevalence (more than 10 per 1000). The case detection is done as per the standardized proforma developed by the WHO.

Isolation

The approach to isolation has radically changed with advances in chemotherapy. No isolation as such is recommended now. Only acute lepromatous cases or those with lepra reaction may be isolated and treated in a leprosy hospital or leprosarium.

Diagnosis

It is performed by:

- Clinical examination.
- Bacteriological examination.
- Culture on mice foot pad.
- Histamine test to detect peripheral nerve damage by injecting 0.1 ml of 1:1000 solution of histamine phosphate or chlorhydrone into hypopigmented areas of suspected patches. Absence of the typical Lewis triple reaction with complete loss of flare response suggests nerve damage.
- Biopsy and histopathological examination.
 - vi. Immunological tests like lepromin test, LTT or LMIT, FLA-ABS test, etc. described already.

Diagnosis is fairly easy in lepromatous and nonlepromatous cases if the disease is just kept in mind. Simple diagnostic guidelines have been outlined by WHO.⁸ Difficulty may arise in the indeterminate type. It should be confirmed by bacteriological examination of the material obtained by the routine 'slit-and-scrape' method from the edge of the lesion or from the lobule of the ear. Nasal smear may also be used. Skin and nerve biopsy may be performed in nonlepromatous cases.

Early detection of subclinical cases is obviously of great importance in control of leprosy.

The following three are helpful in this:⁹

1. Enlargement of great auricular nerve.
2. Search for AFB in ear lobes of contacts of leprosy patients.
3. Immunological tests aimed at assessing cell mediated or humoral immunity. The most commonly used test for cell mediated immunity is the lepromin test, using either the Mitsuda or Dharmendra lepromin preparation. There is evidence that the tests for humoral immunoresponse, such as FLA-ABS, may be much more sensitive than lepromin test alone.⁹

The government has brought out a simple guide for medical officers to help them to diagnose and manage leprosy patients.^{1a} Some practical guidelines for diagnosis are given below.

What are the principles of skin examination? How does one examine the skin?

- Choose a spot where good light is available.
- As far as possible, choose a spot where there is privacy.

- Always examine the whole skin from head to toe.
- Use the same order of examination always so that you do not forget to examine any part of the body.
- Compare both sides of the body.

What should one look for in the skin?

The following features must be noted when examining a patch on the skin:

- *Site:* This is useful for follow-up.
- *Number:* The number of lesions indicates the severity of the disease. This is useful for classification and follow-up.
- *Color:* May be hypopigmented (lighter in color than the rest of the skin), or erythematous (red). Lesions of leprosy are never depigmented. Erythematous color can be used to identify disease activity or a reactional state. (Active lesions or those in reaction are often red).
- *Sensory loss:* This is useful both for diagnosis and classification of leprosy. Loss of sensation is a cardinal sign of leprosy.
- *Tenderness on gentle tapping:* This is seen in reactional states.
- *Presence of infiltration:* This term refers to skin which is thickened, shiny and erythematous. All three features must be present in the same area. This may be seen in severe forms of leprosy.

How should one test for sensation?

Remember the cardinal sign: Hypopigmented or reddish skin lesion(s) with definite loss of sensation.

It is very important to pick up the skill of eliciting sensory loss in skin patch.

- You will need a ball point pen/pin, etc.
- Explain to the person what you are going to do and demonstrate it.
- Touch the skin with the pen/pin. Ask the person to count aloud each time he feels the pen/pin. Alternatively, ask the individual to point to the spot touched with his finger.
- Repeat this procedure a few times until the patient is familiar and comfortable with the procedure.
- Now ask the patient to close his eyes and repeat over the area to be tested. Alternatively, the person should be blindfolded or some barrier should be used to prevent him or her from watching the procedure.

Remember

- Do not keep asking the patient whether he feels the pen/pin or not. You may get misleading results.
- When testing for sensation, touch the skin lightly with the pen/pin. Do not stroke.
- Proceed from the normal skin to the abnormal.
- Give only one stimulus at a time.
- Vary the pace of testing.

What are the general principles of nerve palpation?

Examination of nerves in all the patients is very important for prevention of deformity. This involves two aspects:

- Palpation of the nerves for thickening, tenderness and consistency.
- Assessment of nerve function.
 - When palpating the nerves, you should look for three things: Thickening, tenderness and consistency.
 - When palpating the nerve, the patient should be properly positioned. The examiner should also be positioned correctly.
 - Always compare both sides to assess thickness and consistency.
 - Look at the patient's face while palpating the nerve to elicit tenderness.
 - Always palpate across the course of the nerve.
 - Feel along the nerve as far as possible in both directions.
 - Palpate gently with the pulp of the finger, not the tip.

How should we assess nerve function?

Nerve function assessment includes both motor and sensory function, i.e. Voluntary Muscle Test (VMT) and Sensory Test (ST). Both VMT and ST should be done for:

- All patients with nerve thickening.
- All patients with multibacillary leprosy.

How is voluntary muscle testing done?

Voluntary muscle testing is done by first checking the range of movement to see whether movement is normal, reduced or absent due to paralysis. If movement is normal, a test for resistance is then done. Press gently in

the opposite direction while asking the patient to maintain position, resisting pressure as strongly as possible. Then gradually press more firmly and judge whether resistance is normal, reduced or absent. Always compare the right side with the left. The grading of the result can be done as follows:

- S (Strong)—Able to perform the movement against full resistance.
- W (Weak)—Able to perform the movement but not against full resistance.
- P (Paralysed)—Not able to perform the movement at all.

Treatment

All cases should be detected early and given thorough treatment. From the point of view of control, the aim of treatment should be to render the patients noninfectious as soon as possible, so as to reduce the reservoir of infection in the community. Dapsone was the commonly used antileprosy drug earlier. The WHO⁵ recommended in 1982 that all leprosy patients should receive multidrug therapy.

Multidrug Therapy (MDT): The main objectives of multidrug chemotherapy of leprosy are as follows:

- To interrupt transmission of the infection in the community by rendering infectious patients noninfectious with the use of bactericidal drugs.
- To cure the patient.
- To prevent drug resistance.

The advantages of MDT include lack of drug resistance a shorter course of therapy and, hence, more patient compliance and cost-effectiveness as well as lesser workload on the health delivery system.

Terminology in Relation to MDT: Following the introduction of MDT, the WHO has suggested the following terminology:¹⁰

- **Patient or case of leprosy:** He is a person showing clinical signs of leprosy with or without bacteriological confirmation of diagnosis.
- **Paucibacillary leprosy:** It includes smear negative Intermediate (I), Tuberculoid (T), Borderline Tuberculoid (BT) and Pure neural (N) types of leprosy as per the Indian classification. These make up to 60 percent of patients of leprosy in many health units.¹¹
- **Multibacillary leprosy:** It includes Lepromatous (L) and Borderline Lepromatous (BL) cases and all smear positive cases of leprosy.
- **Adequate treatment:** A patient is said to have taken adequate treatment and completed the multidrug regimen within a reasonably short period of time if:
 - In paucibacillary leprosy, 6 monthly doses of combined therapy have been received within 9 months
 - In multibacillary cases, 24 monthly doses of combined treatment have been received within 36 months.

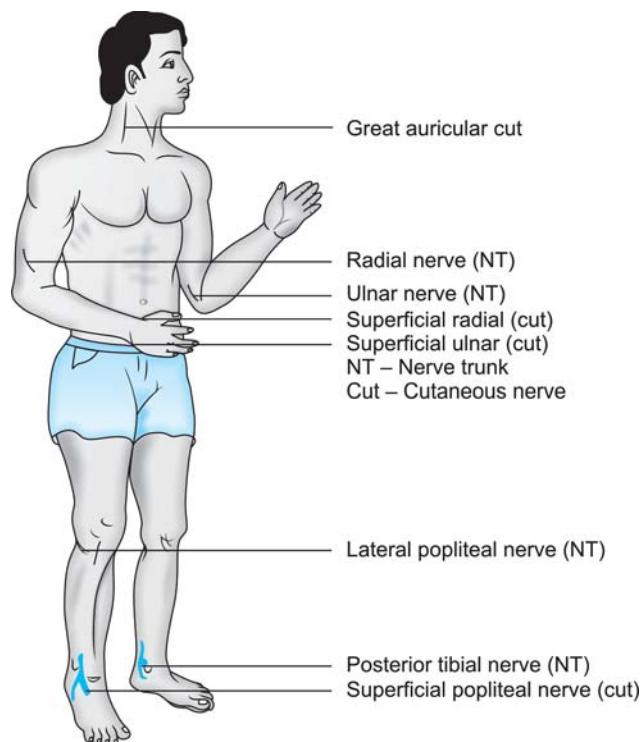


Fig. 18.1: Human body showing nerves commonly involved in leprosy

- **Regular treatment:** A patient may be considered to have had regular treatment if he or she has taken combined treatment for at least two-thirds of the months in any interval of time.

Indices for Monitoring Leprosy Treatment: In view of the possibility of drug resistance, it is important to monitor the course of treatment by the following indices:

- **Bacteriological index (BI):** This index indicates change in the number of leprosy bacilli present in the tissues.⁸ Smears are made from at least seven sites including a nasal smear, both ear lobes and four skin lesions. Each smear is graded separately as belows:

Type of smear	Score
No bacilli seen in 100 fields (Negative)	0
Bacilli found only in some fields. Mean bacilli per field being 1 or less (one plus +)	1
Bacilli found in all field (two plus ++)	2
Many bacilli found in all fields (three plus +++)	3

The scores for all the seven or more smears are added and the mean score found by dividing the total by the number of smears. If BI is less than 2, it is paucibacillary leprosy, if the BI is more than 2, it signifies multibacillary leprosy. The BI is a good indicator of the efficacy of treatment and should be determined every 6 months on all positive cases. Two other types of BI (Dharmendra's scale and Ridley's scale) are used in certain laboratories.

- **Morphological index (MI):** The rationale of determining this index is the finding by Shephard in 1965 that granular and fragmented bacilli cannot be cultured in the foot pads of mice and are hence dead or nonviable. The viable bacilli are present as solid rods with the following characteristics.¹³
 - Length 5 times that of width
 - Ends rounded
 - Sides parallel
 - Uniform staining of the whole bacillus.

The MI (Morphological index) is the percentage of solid rods among 200 organisms counted in a smear stained for demonstrating *M. leprae*.¹⁴ The MI changes more rapidly than the BI. If it shows a rise after an initial decline, it could indicate either inadequate drug intake or development of drug resistance.

Antileprosy Drugs: The drugs used earlier for treatment of leprosy are described in **Table 18.4**. Out of these, ethionamide and prothionamide have now been

TABLE 18.4: Antileprosy drugs and their characteristics¹²

Drug	Dose (mg)	Bactericidal activity
Dapsone	100	+
Rifampicin	600	+++
Ethionamide	375	++
Prothionamide	375	++
Clofazimine	100	+

replaced by the newer drugs ofloxacin and minocycline in the MDT schedule.^{1a}

Dapsone (4,4 diaminodiphenyl sulphone, DDS) is cheap, safe and effective and is easy to use.

Rifampicin is so rapidly bactericidal that a single dose of 600 to 1200 mg renders a LL patient almost noninfectious within a few days. Clinical improvement starts within 7 to 14 days.

Clofazimine is a fat soluble dye deposited in adipose and other cells. It is relatively nontoxic. Resistance to it has not been reported.

Recommended Treatment Regimens

The treatment of leprosy has been relatively rationalised and standardised.^{1a}

Treatment of leprosy under the MDT regimen depends upon the clinical group to which the patient belongs. Grouping is done as per the criteria in **Table 18.5**.

Before starting treatment, fitness of the patient for MDT must be ensured. This is done by looking for jaundice, anemia, tuberculosis and allergy to sulfa drugs.

If the patient is jaundiced, you will have to wait until jaundice subsides.

If the patient is anemic, treat the anaemia also simultaneously.

If the patient is taking rifampicin, ensure that he continues to take rifampicin in the dose required for the treatment of tuberculosis along with other drug regimen required for the treatment of leprosy.

If the patient is known to be allergic to sulpha drugs, dapsone should be avoided.

After grouping the patient and confirming fitness for MDT, treatment should be started as per schedule given in **Table 18.6**.

The once monthly dose should be given under the supervision of a health professional. This helps in ensuring that the patient takes the monthly dose which is important and also in monitoring the patient for assessing the progress of the disease. When the patient has completed the required number of doses, treatment is stopped (release from treatment RFT). Following this, a patient is kept under surveillance (periodically examined) for 2 years (for PB) or 5 years (for MB) to

TABLE 18.5: Patient grouping for MDT

Group criteria	PB single skin lesion (patch)	PB (Pauci-bacillary)	MB (Multibacillary)
Skin lesions	1 skin lesion	2-5 lesions	6 and above
Nerve involvement	No nerve involvement	No nerve involvement/ only one nerve trunk	More than one trunk involvement
Skin smear	Negative at all sites	Negative at all sites	Positive at any site

TABLE 18.6: Dosage schedule for MDT

	Drugs used	Dosage (adults)	Frequency of administration	Criteria for cure
MB leprosy	Rifampicin	600 mg	Once monthly	Completion of 12 monthly pulses within 18 months
	Dapsone	100 mg	Daily	
	Clofazimine	300 mg 50 mg	Once monthly Daily	
PB leprosy	Rifampicin	600 mg	Once monthly	Completion of 6 monthly pulses within 9 months
	Dapsone	100 mg	Daily	
Single skin lesion leprosy	Rifampicin	600 mg	Single dose	Administration of single dose of treatment (ROM)
	Ofloxacin	400 mg	Single dose	
	Minocycline	100 mg	Single dose	

promptly diagnose and manage reaction or relapse of the disease.

If a patient, sometime after he has been declared as cured (RFT) comes with reappearance or increase in the number of lesions he should be considered a case of relapse and given MB regimen whatever might be the grouping of the disease.

Reaction in Leprosy and their Management

What is reaction in leprosy?

It is an acute inflammatory event occurring in the course of the disease. It can occur at anytime before, during or after treatment. It must be promptly diagnosed and treated to prevent any disability. Patients with following characteristics are more likely to develop lepra reactions.

- Many lesions
- Lesions close to the nerve
- Lesions on the face.

These patients should be monitored more frequently by doing clinical examination including VMT and ST for early detection of reaction and its prompt management.

What are the types of lepra reaction?

There are two principal types of lepra reactions: Type 1 and Type 2. Type 1 lepra reaction also known as Reversal Reaction may occur both in PB and MB leprosy. Type 2 reaction is also known as Erythema Nodosum Leprosum (ENL) and occurs only in severe forms of MB leprosy.

Skin or nerves or both may be affected in reaction.

Skin or nerves or both may be affected in reaction.

What are the features of lepra reactions?

These are given in **Table 18.7**.

How do we manage a patient with type-1 reaction?

The patient will need corticosteroids in addition to rest and analgesics. The drug of choice is prednisolone in the case of type 1 reaction. The usual course begins with 40 to 60 mg daily (up to a maximum of 1 mg/kg of body weight), and the reaction is generally controlled within a few days. The dose is then gradually reduced weekly or fortnightly and eventually stopped. Proper precaution should be taken in patients with diabetes, peptic ulcer, hypertension, etc.

A suggested schedule for prednisolone therapy for an adult patient is as follows:

- 40 mg once a day for the first 2 weeks, then
- 30 mg once a day for weeks 3 and 4
- 20 mg once a day for weeks 5 and 6
- 15 mg once a day for weeks 7 and 8
- 10 mg once a day for weeks 9 and 10
- 5 mg once a day for weeks 11 and 12

It is also important to provide rest to the affected nerve until symptoms clear by applying a padded splint or any suitable alternative material to immobilize the joints near the affected nerve. The aim is to maintain the limb and the affected nerve in the resting position to reduce pain and swelling and prevent worsening of the nerve damage.

In case of a type 1 reaction not responding to treatment after 4 weeks of treatment with prednisolone or at any time showing signs of worsening, the patient should be referred to the nearest referral center.

Type 1 reactions, which occur after the completion of treatment, should also be managed as mentioned above.

Continue MDT if the patient is under treatment.

TABLE 18.7: Features of lepra reactions (Reversal reaction)

Features	Type 1 (Reversal reaction)	Type 2 (ENL reaction)
Skin	Existing lesions suddenly become red, swollen warm, and tender. New lesions may appear	Red, painful, tender, subcutaneous (deep) nodules (ENL) appear commonly on face and arms and legs. They appear in groups and subside within a few days.
Nerves	Lesions when subsiding may show scales on the surface. Nerves close to the skin may become enlarged, tender and painful (neuritis) with loss of nerve function	Nerves may be affected but not as commonly as in type 1
Other organs	Not affected	Other organs like eye, joints, bones, testes, kidney may be affected
General symptoms	Not common	Fever, joint pains, fatigue

How do we manage a patient with type 2 reaction?

Treatment with prednisolone should be started immediately, as described under Type 1 reaction, along with bed rest and immobilisation of the affected nerves. Symptomatic treatment for fever headache, etc. should be added.

In case of an ENL reaction not responding to treatment after 4 weeks of treatment with prednisolone or at any time showing signs of worsening, the patient should be referred to the nearest referral center.

Clofazimine is also effective for ENL, but is less potent than corticosteroids and often takes 4 to 6 weeks to develop its full effects, so it should never be started as the sole agent for the treatment of severe ENL. However, clofazimine may be extremely useful for reducing or withdrawing corticosteroids in patients who have become dependent on them. The dose required in such cases is 300 mg daily, which may be given in three divided daily doses to minimise the gastrointestinal side effects. The total duration of high-dose clofazimine therapy should not exceed 12 months.

Thalidomide is also effective for the treatment of severe ENL. It must be pointed out though, that because of its teratogenic effects, thalidomide should never be given to women of child bearing age. It is not available at most treatment centers.

Patients may present with *iridocyclitis* during ENL reaction. The main symptoms are pain, redness and watering of the eyes. On examination, circumcorneal congestion with small irregularly shaped pupils, which respond sluggishly to light, is seen. Mild cases may be treated with topical application of atropine and steroid eye drops or ointments. More severe cases should be referred to the nearest hospital.

Continue MDT if the patient is under treatment.

Indications for referral include:

- Failure to respond after 4 weeks of steroid treatment
- Eye involvement
- Other systemic involvement.

Disinfection

All that is needed is concurrent disinfection or proper disposal of nasal discharges, as long as the patient is infectious.

Surveillance

After completion of therapy with MDT, clinical and bacteriological monitoring of the patients is necessary to ensure that the therapy has been successful and the disease has not relapsed. In paucibacillary leprosy, clinical surveillance once in a year is required for at least two years. In multibacillary leprosy, clinical and bacteriological surveillance is required once in a year for at least 5 years.¹⁰

Leprosy Vaccine

Three leprosy vaccines are currently undergoing large scale human trials. The first is the WHO vaccine developed by Dr J Convict in Venezuela. It is a combined vaccine containing BCG and heat killed *M. leprae*, harvested from armadillo. The rationale for incorporating BCG in it is the fact that BCG has some protective action against leprosy. The other two are Indian vaccines—the ICRC vaccine developed by Dr MG Deo at Cancer Research Institute, Mumbai and the MW vaccine, developed by Dr GP Talwar at National Institute of Immunology, New Delhi from *Mycobact W*, which is a nonpathological atypical *Mycobacterium* sharing antigens with *M. leprae*. The MW vaccine is similar to the ICRC vaccine. The latter contains X-irradiated attenuated ICRC bacillus, which was cultivated in 1958 by Dr Khanolkar. The ICRC bacillus is a close cousin of *M. leprae* and cross reacts with it. The ICRC vaccine was prepared in 1979 and has undergone different types of trials since then. It is not only immunoprophylactic but also immunotherapeutic. Thus it induces lepromin conversion and clinical and pathological improvement in a significant proportion of patients with lepromatous leprosy.

Health Education

People should be made to realize that simple, cheap and efficient treatment for leprosy is now freely available. The fear and stigma attached to leprosy should be removed.

In order to encourage health professionals to disseminate appropriate health education in relation to leprosy, some key messages are given below.

Leprosy Educational Messages:

- Leprosy is the least communicable of all infectious diseases.
- Four out of five leprosy cases in India are of the noninfectious kind.
- The treatment available today renders infectious cases noninfectious in as little as five or six weeks with the help of MDT.
- Leprosy does not strike overnight. It can take years to manifest itself. A very prolonged exposure to untreated, infectious cases is necessary for the signs of the disease to become manifest.
- Leprosy is neither hereditary nor a curse. It is caused by a germ.
- Leprosy is completely curable.
- Leprosy need not result in deformities at all. If detected and treated early, it leaves no physical scars.
- The nerve and limb complications that lead to deformity are not inevitable; they are the result of neglect.
- Leprosy can be cured even at an advanced stage, though it may not be possible to correct all the deformities.

- Leprosy is not a poor man's disease. It can occur in any social or economic class, even among the affluent.
- Leprosy is not only an adult's disease: 20 percent of all newly detected cases are children.
- Leprosy is more than just a medical problem and, for the disease to be fully treated, community support is as important as medical help.
- The leprosy patients can stay at home without any risk and continue to work because, once the treatment is started, the disease is contained.
- The first signs of leprosy are:
 - A pale or red patch which could be oily, smooth or dry. The patch is neither painful nor itchy.
 - Loss of hair and lack of sweating in the discolored area.
 - Numbness in the patch.
 - A tingling or “ant-crawling” sensation along the affected nerve.
- Leprosy is curable. All it needs is:
 - Early detection
 - Early intervention
 - Sustained treatment
 - Community support throughout.
- Treatment of leprosy is absolutely free.

Rehabilitation

All cured cases should be provided suitable jobs through government or private agencies. Modern plastic and orthopedic surgery and physiotherapy should be used to treat disfiguration and deformities and to restore appearance and function. Burnt out cases with marked deformities may be kept in special rehabilitation centers.

The definition of “rehabilitation” given by WHO envisages the return of a person to his normal social environment after he has been adequately trained, mentally and vocationally, for the role he has to play. Rehabilitation has to be viewed from this viewpoint and its success or failure judged on this criterion. Institutional rehabilitation is costly and time-consuming. Moreover, follow-up studies of leprosy patients given rehabilitation training in institutions and then discharged, in the hope that they would earn their living through the skills learned, revealed alarming findings. According to the Director, Gandhi Memorial Leprosy Foundation, Wardha, two studies conducted there showed that more than half patients discharged from leprosy rehabilitation centres were just not traceable at the address given, most having taken to begging. Of those traced, none was earning his livelihood through the skill in which he was trained. The reason is that the institutional support available for providing raw material and job orders, as also for marketing the goods produced, is not available once the inmate trainees leave the leprosy institution. It was recommended that an alternate and preferable method of rehabilitating leprosy patients would be to provide them assistance through

existing schemes like IRDP, etc. With such assistance, they can set up shops and purchase cows, goats, sheep, sewing machines, cycle rickshaw, etc. thus earning their livelihood (**Table 18.8**).

SOCIAL MEASURES

Treatment of all known cases should be compulsory. The Lepers Act, 1898, providing for the segregation and medical treatment of lepers, was outdated and has been repealed.

MANAGERIAL ASPECTS

Any large national health program, though conceptually sound, can be a failure if managerial and administrative support is not provided for its implementation. Leprosy control is no exception. Availability of adequate infrastructure, trained personnel, medicines, equipment, transport and finances must be ensured. These aspects are discussed in detail under the National Leprosy Eradication Program described later.

EVALUATION

Proper evaluation of a health program is necessary to check whether the desired results are being achieved and whether any program modifications are needed. The indicators for evaluation are of two types—operational and epidemiological.¹⁰ *Operational indicators* relate to case finding, treatment, relapse and disabilities. Examples of such indicators are:

- Case detection ratio (the ratio of leprosy cases registered to the estimated number of cases)
- Ratio of children below 14 years age among the total number of newly detected cases
- Proportion of multibacillary cases on regular treatment during an year
- Relapse rate. The last is a good indicator of the efficacy of the drug regimen.

Epidemiological indicators relate to the effectiveness of the program as such. These include age, sex and area wise incidence and prevalence rates.

Leprosy Organizations in India

There are many voluntary organizations working in the field of leprosy in India. These include:

- Leprosy Mission: This was the first voluntary organization for leprosy work in India. It was started in 1874 by Bailey in Chamba, Himachal Pradesh. Its headquarter is presently in Purulia, West Bengal.
- Hind Kushth Nivaran Sangh: This pioneer organisation was established in India in 1974 as a branch of the British Empire Leprosy Relief Association founded in London in 1923.
- Gandhi Memorial Leprosy Foundation, Sevagram, Wardha.

TABLE 18.8: Side effects of antileprosy drugs: There are as below:^{1a}

<i>Common side effects</i>	<i>Signs and symptoms</i>	<i>What to do if side effects occur</i>
Dapsone		
Anemia	Paleness inside the lower eyelids, mouth and fingernails. Tiredness, edema of feet and breathlessness	Give anti-worm treatment and iron tablets. Continue dapsone
Severe skin complication (Exfoliative dermatitis)	Extensive scaling, itching, ulcers in the mouth and eyes, jaundice and reduced urine output	stop dapsone. Refer to hospital immediately. Never restart symptomatic treatment.
Abdominal symptoms	Abdominal pain, nausea, and vomiting on high doses	Reassure the patient
Liver damage (Hepatitis)	Jaundice (yellow color of, skin, eyeballs and urine)	Stop dapsone. Refer to hospital.
Kidney damage (Nephritis)	Loss of appetite and vomiting	Restart after the jaundice subsides
	Edema of face and feet	Stop dapsone. Refer to hospital
	Reduced urine output	
Rifampicin		
No significance	Redish coloration of urine, saliva and sweat	Reassure the patient
Hepatitis (Liver damage)	Jaundice (yellow color of skin, eyeballs and urine)	Stop rifampicin. Refer to hospital
	Loss of appetite and vomiting	Restart after the jaundice subsides
Flu like illness	Fever, malaise and bodyache	Symptomatic treatment
Allergy	Skin rash	Stop rifampicin
Clofazimine		
No significance	Brownish-red discoloration of skin, urine, and body fluids	Reassure the patient, it will go after completion of treatment
Ichthyosis	Dryness and thickening of the skin, itching	Apply oil to the skin.
Eye	Conjunctival dryness	Reassure the patient
Abdominal symptoms	Abdominal pain, nausea and vomiting on high doses	Moistening eye drops Symptomatic treatment
		Reassure the patient
Ofloxacin*		
Abdominal symptoms	Abdominal pain, nausea and vomiting on high doses	Symptomatic treatment Reassure the patient
Central nervous system complaints	Sleeplessness, headaches, dizziness, nervousness, hallucinations	Symptomatic treatment Reassure the patient
Minocycline*		
Dizziness	—	Reassure the patient
Discoloration of the teeth in children	—	Reassure the patient
Pigmentation of the mucous membrane	—	Reassure the patient
Abdominal symptoms	Abdominal pain, nausea and vomiting on high doses	Symptomatic treatment Reassure the patient

^aWith a single dose regimen (ROM) complications are rare. However this drug is also not recommended for use in pregnant women and children below five years of age.

- Belgium Leprosy Center (Polambakkam, Chennai).
- Danish Save the Children Fund.
- Bharat Sewashram Sangh, Jamshedpur, Bihar.
- Kashi Kushth Seva Sangh, Varanasi, UP.
- Tapovan, Amravati, Maharashtra.
- Hindu Mission, Chennai, Tamil Nadu.

Two other important organizations active in the field of leprosy are the Jalma Central Institute of Leprosy

(taken over by ICMR in 1975) and the Central Leprosy Teaching and Research Institute, Chingleput.

National Leprosy Eradication Program

The government started the National Leprosy Control Program in 1955. The objective was “to control the spread of disease and to render modern treatment faci-

lities to patients". In 1983 the program was redesignated as National Leprosy Eradication Program and the goal set was "to achieve arrest of the disease activity in all the known leprosy cases in the country by the year 2000". After the World Health Assembly resolution in 1991, the objective of the program was redefined as "to achieve the elimination of leprosy in the country by the year 2000, thereby reducing the case load to 1 per 10,000 population or less".¹ It is to be noted that when prevalence of leprosy falls below 1 in 10,000, disease transmission is deemed to have been arrested. The program receives 100 percent financial support from the Center government. The program is implemented through the establishment of Leprosy Control Units, Survey, Education and Treatment Centers, Urban Leprosy Centers, Temporary Hospitalization Wards, Reconstructive Surgery Units, etc.

At the Center level, the Leprosy Cell of the Directorate General of Health Services is responsible for planning, supervision and monitoring of the program. The cell is under the control of the Asst Director General (Leprosy), who advises the Government on all antileprosy activities in the country. He is under the overall supervision of the Director General of Health Services and the Ministry of Health and Family Welfare.

At the state level, the State Leprosy Officer is responsible for the organization, supervision, guidance and monitoring of all antileprosy activities. At the district level, the District Leprosy Officer is responsible for implementation and supervision of the Program. At the peripheral level, the Medical Officer Incharge of Leprosy Control Unit/Center and the Medical Officer in the Primary Health Center, to which a Survey, Education and Treatment Center Unit is attached, are responsible for anti-leprosy activities (**Table 18.9**).

STRATEGIES

The program has the following four strategies:¹

- Provide domiciliary treatment (MDT) in endemic districts through staff trained in leprosy.
- Provide services through mobile leprosy treatment units with the help of primary health care staff in moderate and low endemic districts.
- Organize health education to patients, their families and the community to increase awareness and to remove stigma.
- Provide deformity and ulcer care and medical rehabilitation services to the needy patients.

INFRASTRUCTURE

It is given in the **Table 18.9**.

The components of the SET approach as followed by the SET centers are explained below:

TABLE 18.9: Various units of National Leprosy Eradication Program

Unit	Scale	No. existing	Remarks
Leprosy control unit (LCU) or modified LCU	One per 4.5 lakh population	778	In endemic rural areas headed by a Medical Officer
Urban leprosy center (ULC)	One for 50,000 population	907	Manned by one paramedical worker responsible to the MO of a dispensary or hospital
Survey, education and treatment center (SET)	One per 25,000 population	5744	In low endemic areas, attached to a PHC or hospital manned by a paramedical worker under guidance of MO, PHC
Mobile leprosy treatment units (MLTU)		350	In non-endemic districts headed by a Medical Officer
Temporary hospitalization ward (THW)		290	
Reconstructive surgery units (RSU)		75	
Sample survey cum assessment unit (SSAU)		40	

SET Approach

Survey: This is done house to house, at schools, by family visits, and through health educational approaches, voluntary reporting, contact examinations and referral services. Diagnosis is confirmed by the doctor and, sometimes, in the absence of a doctor, by the nonmedical supervisor.

Education: This is imparted through individual and mass communication by utilizing color picture cards of patient with hints of diagnostic signs and symptoms, pamphlets, posters and booklets on leprosy. Individual and group talks are arranged. The mass media like radio, television, newspapers and journals are used.

Treatment: The line of treatment is indicated by the doctor or the nonmedical supervisor. Treatment is delivered by the leprosy paramedical worker who holds weekly or fortnightly outdoor clinics at vantage points in the area. Domiciliary treatment is also given through the network of outdoor clinics. Segregation of leprosy patients has no place in the modern leprosy control program. Clinics are held at health centers and hospitals. The new multidrug regimen is implemented under the close supervision of the doctor.

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- Genital scabies
 - Virus B hepatitis
 - Genital pediculosis
 - Genital molluscum contagiosum.
 - AIDS: Acquired Immune Deficiency Syndrome is the latest STD that has assumed great importance.²
A detailed classification of STD has been given by the WHO.

History and Prevalence

WHO has labelled three diseases as the greatest enemies of mankind: Malaria, Tuberculosis and STD. The incidence of STD among young people has increased in many countries, especially among females between 15 and 19 years of age. An STD is a self-inflicted wound that remains hidden and untreated because of shame and stigma. Untold suffering of a large number of people goes unnoticed and STDs continue to spread in spite of availability of specific treatment³. The sexual behavior of adolescents is rapidly changing in many parts of the world, the trend being towards more and earlier sexual activity. A striking increase in the incidence of sexually transmitted diseases, especially "gonorrhoea", has been observed since 1960. In some countries the reported incidence for persons below 17 years of age doubled for boys and tripled for girls between 1966 and 1971. The age group 16 to 17 years showed a fifty to eighty-fold increase over the age group below 15 years, indicating the start of sexual activity by a large group of high-risk adolescents at that point.⁴

True prevalence rates and incidence rates of STD are not known because, firstly, the disease is concealed by the patients and, secondly, proper diagnosis is often not made. Data from STD clinics all over India⁵ reveals that the number of cases reported was about 1.3 million annually during 1986-1990. Studies conducted by the National Institute of Communicable Diseases⁶ revealed that sera of antenatal mothers was positive for syphilis by VDRL test in 0.6 to 1.4 percent cases while seropositivity in patients above 15 years of age under treatment in different hospital departments was 5.8 percent in males and 5.9 percent in females. In another study, 2.2 percent cases of STD were found to have two diseases concomitantly, the most common association being that of gonorrhoea and syphilis.¹ Emergence of antimicrobial resistance to STD agents is adding to the problems of an effective patient care system. Further, the classical or first generation STD diseases are tending to be replaced by the newer or 'second generation' STDs.⁷

The reasons for the recent increase in incidence of STD are as follows:

Sexually Transmitted Diseases or Venereal Diseases

The adjective *venereal* is derived from Venus, the Goddess of love. Venereal diseases are transmitted through sexual intercourse. Rarely, transmission may be indirect, e.g. through towels in case of vulvovaginitis in young children. In view of the stigma attached to the label VD (Venereal Disease), the WHO rephrased in 1974 the nomenclature to sexually transmitted diseases. This nomenclature also made it possible to include in this group, besides the five classical venereal diseases, several other conditions in which sex plays an important epidemiological role.

Classification¹

- Classical STD:
 - Syphilis
 - Gonorrhoea
 - Chancroid
 - Lymphogranuloma venereum
 - Granuloma inguinale.
- Other STD where sexual transmission is epidemiologically important:
 - Nongonococcal urethritis
 - Herpes progeneralis
 - Genital warts
 - Trichomoniasis
 - Moniliasis.
- Diseases where sexual transmission is possible but not epidemiologically important. Usually these are not labelled as STD. Some of these are listed below:

- Change in sexual behavior.
- Increased use of oral contraceptives with corresponding decrease in use of condom, which has a protective role.

- Increased mobility to foreign countries with resultant loss of stable home conditions.
- Increased migration from rural to urban areas where chances of exposure are greater.
- Increase in homosexuality.

One in every five STD patients in the world is an Indian. The gravity of situation is deepened by the fact that certain STDs act as cofactors in development of HIV infection. In view of the fact that 95 percent STDs are preventable by using a good quality condom, urgent steps are needed to promote safe sex.

Syphilis (ICD-A53.9)

Syphilis is a fairly common STD and will hence be described in detail. Surveys in various parts of India indicate a prevalence of 0.5 to 7 percent.⁸ According to a recent survey in Himachal Pradesh, VDRL overall positivity was 21.5 percent. 16.5 percent had titres 1:8 and above.

CLINICAL FEATURES

These depend upon whether the disease is congenital or acquired. Acquired syphilis manifests the following three stages:

Primary Stage

A small red spot is noticed on the penis 3 to 4 weeks after sexual intercourse. It is painless and develops gradually into a well defined hard sore or hard chancre in 2 to 3 weeks. The untreated sore heals in 6 to 8 weeks. A painless bubo in the groin follows. After another fortnight, the glands in neck, axilla and epitrochlear region are enlarged. The penile sore may sometimes be absent.

Diagnosis: Serous exudate from the sore is positive for the causative agent. Serological tests become positive 6 to 8 weeks after sexual intercourse and remain so in all stages. The tests depend on two classes of antibodies as follows:

1. *Tests related to nonspecific reagin antibodies (IgG and IgM)*—These antibodies react with lipoidal antigen produced as a result of the action of *T. pallidum* on host tissue. The following reagin antibody tests are used:
 - *Rapid plasma reagin (RPR) test* This can be automated and used as a screening test. It is a complement fixation test.
 - *VDRL test:* It is a flocculation test. Its special merit is that it is quantitative in nature and the titre reflects the activity of disease. It becomes positive during the primary stage, reaches its maximum (1:32 or more) in the secondary stage and falls on successful treatment to 1:4 or less and may even become negative if treatment is given early

enough. A false positive test has usually a low titre (1:8 or less). VDRL test is a well established and effective method for mass screening of treponemal infection. It is not specific but it is cheap and easy to perform in routine laboratories and has a high degree of sensitivity. The major disadvantage of this test, however, is its biological false positivity which can be largely obviated by using standard reagents, following correct techniques and routinely quantitating the reactive sera.⁸

2. *Tests related to specific antitreponemal antibodies*—These react with the specific antigen of *T. pallidum*. These tests do not differentiate between present and past infection and hence are of no value in assessing the activity of the disease. These are reserved for verification procedures in cases that present a diagnostic problem. False positives are much less common with treponemal than with nontreponemal antigens.

In view of the excellent serological tests available, dark field microscopy is now rarely used for diagnosis of syphilis.⁹ However, it is still indispensable for diagnosis of suspected early seronegative primary syphilis.¹⁰

Secondary Stage

It lasts four weeks to six months after the appearance of chancre. It is characterised by sore throat, anemia, skin rashes, enlargement of glands and pain and swelling in bones and joints. Soft warty condylomata are seen on the moist surfaces like anus, vulva and the skin under the breasts. Ulcer in throat and white mucous patches inside the cheeks may also occur.

Tertiary Stage

The characteristic feature here is the formation of gummata (nodules), which may suppurate and form ulcers on the skin. They are formed in muscles, bones and in internal organs like liver, spleen, testes and lungs. Involvement of the heart and blood vessels is both common and serious.

CAUSATIVE AGENT

Syphilis is caused by *Treponema pallidum*, a spirochaete. It dies rapidly outside the body. It is killed by drying, heating and ordinary antiseptics.

SOURCES OF INFECTION

Patients with primary sore in the first stage and with condylomata and mucous patches in the second stage, when saliva and urine may also contain the germs. Patients with tertiary syphilis are usually noninfective. However, a broken and ulcerating gumma in throat or on the skin may be infective in the third stage.

MODE OF TRANSMISSION

Transmitted mostly through sexual intercourse in primary and secondary stages; rarely by kissing when infective mucous patches are present in the mouth. Infection may be passed out in saliva, semen, blood and vaginal discharges. Congenital syphilis is transmitted to the child from the mother through placenta. Extragenital infection may occur through cuts or wounds or blood transfusion.

PERIOD OF COMMUNICABILITY

The patient remains infective as long as primary sore, condylomata, mucous patches or ulcerating gummata are not healed. Some patients may be intermittently infective for 2 to 4 years. Adequate penicillin therapy ends infectivity within 24 hours.

SUSCEPTIBILITY AND RESISTANCE

Susceptibility is general, though infection occurs in only 10 percent cases after exposure. There is no natural immunity. Infection leads to gradual development of resistance to *T. pallidum*. Immunity may fail to develop if early treatment is given in the primary or secondary stages.¹⁰

INCUBATION PERIOD

Ten days to ten weeks, average three weeks.

METHODS OF CONTROL

Preventive Measures

Congenital syphilis can be prevented by serological examination during pregnancy and treatment of positive reactors. Acquired syphilis can be prevented by:

- Health and sex education aimed at controlling unsafe sex and at teaching the use of personal prophylaxis before, during and after exposure to high risk contacts.
- Control of prostitution.
- Early diagnosis and treatment.

Disability due to late manifestations of syphilis can be prevented by proper treatment of known patients.

Control of Patients, Contacts and the Immediate Environment

Report to Health Authorities

Isolation: Precautions need to be taken when handling blood and body fluids of patients in primary and secondary stages. No such precautions are needed for those having latent or tertiary syphilis.¹⁰ Patients should avoid sexual intercourse till the lesions clear up.

Contacts: Sexual partners of syphilis patients should be traced, investigated and treated, if found infected. Contact tracing is determined by the stage of disease in the patient as below:¹⁰

Congenital syphilis: All members of the immediate family.

Primary syphilis: Sexual contacts within three months prior to onset of symptoms.

Secondary syphilis: Contacts during preceding six months.

Early latent syphilis: As above. If the time of primary and secondary lesions cannot be established, contacts during previous one year should be traced.

Late and late latent syphilis: Marital partners and children of infected mothers.

Specific Treatment^{1,11}

- For early syphilis and for syphilis of 2 years' duration or less (whether primary, secondary or latent): The treatment of choice is a single intramuscular injection of aqueous benzathine penicillin G, 2.4 million units after sensitivity test. As an alternative, 0.6 million units IM may be given daily for 10 days. In case of penicillin allergy, oral tetracycline or erythromycin stearate 500 mg qid for 10 days.
- For syphilis of more than 2 years duration (latent syphilis, late benign tertiary syphilis and neuro-syphilis): Benzathine penicillin G 2.4 million units weekly for three weeks (7.2 million). If aqueous procaine penicillin is used, 0.6 million units daily for 15 days (9 million units) and in case of neuro-syphilis, 1.2 million units daily for 21 days. In case of penicillin allergy, erythromycin or tetracycline 500 mg qid for 10 days.
- For pregnant women, same as above but tetracycline not to be used.
- *For spouse*, examination and, if necessary, treatment for syphilis must be carried out.
- *Retreatment should be considered when*
 - Signs and symptoms of syphilis persist or recur.
 - Sustained two-fold increase in the titre of a nontreponemal test occurs.
 - An initially high titre of a nontreponemal test fails to show two-fold decrease within a year.
- **Congenital syphilis:**
 - Up to 2 years age: Aqueous procaine penicillin G 0.3 million units IM daily for 10 days irrespective of weight. Alternatively, benzathine penicillin 1.2 million units single injection. Corticosteroids may be used simultaneously in proper dose.
 - Above 2 years age: Same as adult dose for early syphilis. Tetracycline not to be given to children below 8 years of age.

Long-acting benzathine penicillin 2.4 Megaunits can be given in two doses of 1.2 Megaunits, one on each buttock, at one and the same time. Serum tests are done every 3 months in first year and every 6 months in the second and third year.

Gonorrhea (ICD-A54.9)

CLINICAL FEATURES

The acute stage is characterized by inflammation of urethra in males and of urethra, cervix and vagina in females. There is acute burning sensation with pain and pus discharge while passing urine. Later the pus becomes thin and persists life long.

In males, the infection spreads to prostate, seminal vesicles, bladder, renal pelvis or rectum by contiguity and through lymphatics. In females, it spreads to uterus, tubes, peritoneum and Bartholin glands. Females are particularly liable to spread the disease since they may have few symptoms or obvious signs.

The infection may spread through blood to heart, meninges, joints, muscles, tendons and eyes.

COMPLICATIONS OF GONORRHEA

In males, urethral stricture develops after several years, but this is becoming rare with the widespread use of antibiotics. In females, the most common and most important complication is pelvic inflammatory disease (PID) which is estimated to occur in 10 to 15 percent of untreated women.¹² The infection extends from the cervix through the uterus to the fallopian tubes, producing acute salpingitis which is the basis of the PID. It may result in reduced fertility, infertility and a tendency to tubal pregnancy and recurrent salpingitis. On a global scale, gonorrhea is the most common preventable cause of PID and tubal infertility. In some countries, gonorrhea accounts for a large proportion of PID cases: 45 percent in USA, 38 percent in Uganda, 43 percent in Kenya and 46 percent in Zambia.¹² However, this figure is only 9 percent in case of India.¹³

DIAGNOSIS

Typical gram-negative intracellular diplococci seen in male urethral smears are diagnostic of gonorrhea. Similar organisms in smears from cervix uteri are suggestive of gonorrhea in the female.¹⁰ Repeated cervical and rectal cultures may be necessary to confirm the diagnosis in women. No reliable serological tests are available at present for diagnosis of gonorrhea. It is important to properly confirm the diagnosis of gonorrhea in view of the possible misdiagnosis of nongonococcal urethritis (NGU) and nongonococcal mucopurulent cervicitis which may also be transmitted sexually.

In many countries the incidence of NGU exceeds that of gonorrhea.¹⁰ In USA, about 40 percent of NGU is caused by *Chlamydia trachomatis*.

CAUSATIVE AGENT

Neisseria gonorrhoeae which is seen as kidney shaped diplococci occurring freely as well as in pus cells.

SOURCE OF INFECTION AND PERIOD OF INFECTIVITY

Untreated cases are infective for months. Women form the larger reservoir since infection at the cervix is painless and remains undiagnosed and untreated. Specific chemotherapy renders a case noninfective within hours, except in case of infection with penicillin resistant strains.

MODE OF SPREAD

- Gonorrhea spreads by sexual intercourse, the chances of acquiring gonorrhea after a single exposure being 20 to 35 percent for men¹⁴ and probably double this in case of women.¹² Oropharyngeal gonorrhea is getting more common in both sexes due to increased orogenital sexual contact. It is particularly common among homosexual males, in whom an incidence of 10 to 20 percent has been reported.¹²
- In nursery schools and orphanages, infected towels may cause vulvovaginitis in girls, but this is rare.
- Purulent conjunctivitis may occur by infection through fingers.
- Ophthalmia neonatorum may occur in a newborn if there is infection in the birth canal at the time of delivery.

INCUBATION PERIOD

2 to 7 days; usually 3 to 4 days.

METHODS OF CONTROL

General preventive measures are the same as in case of syphilis.

TREATMENT

- Uncomplicated gonococcal infection in adults is treated by aqueous procaine penicillin G (APPG) 2.4 million units divided into two halves for intramuscular injection into each buttock, simultaneously with 1 g probenecid given orally immediately prior to the injection. Alternatively, 3.5 g penicillin and 1 g probenecid can be given orally together. In case of penicillin allergy, tetracycline is given orally in a dose of 1.5 g initially followed by 500 mg four times a day for 10 days.
- The sex partner should be treated simultaneously when a patient of gonorrhea is treated.
- Benzathine penicillin G has no place in the treatment of gonorrhea.
- For pregnant women allergic to penicillin, erythromycin (0.5 g orally four times a day for 4 days) should be used in place of tetracycline.
- Gonococcal ophthalmia neonatorum:
 - A single injection of procaine penicillin 300,000 units IM.

- Local antibiotic treatment is a must. Ideally, freshly prepared penicillin should be instilled as eye drops, hourly for 6 hours and then 2 hourly till clinical cure. If not possible, then tetracycline eye ointment should be applied locally.

Penicillin resistant strains of *N. gonorrhoeae* are found now with increasing frequency in many parts of the world, though yet not so much in India. These strains are referred to as beta-lactamase producing or penicillinase producing *N. gonorrhoeae* (PPNG). Infection with penicillin resistant strains can be treated by 10 tablets of cotrimoxazole (sulfamethoxazole + trimethoprim) given daily for three days or, alternatively, by a single intramuscular injection of streptomycin 2 g.¹⁰

Follow-up is necessary in gonorrhea, as in syphilis, to prevent further spread and complications.

Trichomonal Vaginitis and Urethritis (ICD-A59.0)

Trichomonal vaginitis is a protozoal infection of vagina and urethra caused by a flagellate parasite—*Trichomonas vaginalis*. The parasite lives in vagina and urethra of the female and in urethra of the male. It has often been isolated from the undersurface of prepuce in men whose wives are infected. Diagnosis is made by detecting the parasite in vaginal and urethral discharges.

SYMPTOMS

In males, infection of urethra may not produce any symptoms except mucoid discharge and slight irritation. In females, typical symptoms are vulvar irritation. In females, typical symptoms are vulvar irritation and frothy yellowish discharge with putrid odor. All cases of leucorrhea should be examined for trichomonal infection.

TREATMENT

Metronidazole is highly effective. Single dose regimen (2 g) is as effective as 200 mg thrice daily for 7 days with a cure rate of more than 90 percent. Relapses are rare. The high cure rate is further improved marginally if the husband is also treated likewise. However, this need not be insisted if not feasible, because the additional benefit gained is minimal.

Chancroid (Soft Sore) (ICD-A57)

IDENTIFICATION

A small red lesion appears on the genitals as a papule or vesicle which becomes a pustule and ulcerates. Ulcers are often multiple and painful with soft bleeding surface and ragged undermined edges, in contrast to the hard sore of syphilis. Lymph glands are enlarged, tender and

matted; they often show suppuration, unlike those in syphilis. Phimosi is a common complication in males. Extragenital lesions on lips, tongue, chin, breast and umbilicus may occur.

EPIDEMIOLOGY

The infection is fairly widespread, particularly in the tropics and subtropics. The causative agent is a slender rod called 'Ducrey bacillus' (*Haemophilus ducreyi*). Abrasions, cuts and wounds predispose to infection. The person remains infective till the lesion heals. Diagnosis is made by examining the discharge from the ulcer.

INCUBATION PERIOD

2 to 5 day; longest 10 days; 24 hours if there is abrasion.

TREATMENT

Sulphadimidine 4 g daily for 10 to 15 days in divided doses or tetracycline 0.5 g four times a day for 10 days.

Lymphogranuloma Venereum (LGV) ICD-A55

It is more common in South India. It accounts for 6 percent of all STD in Chennai.¹⁵

CLINICAL FEATURES

It is a venereally acquired infection of lymph channels and lymph nodes. The lesion starts as a small transient papule or vesicle on external genitals which heals unnoticed. At a later stage, it may recur in the following forms:

- Climatic bubo, so called because it is found more in tropics and subtropics. Inguinal glands are enlarged and matted, forming a tender mass which may burst and give rise to discharging sinuses.
- Anal or ano-rectal stricture due to polypoid growth in rectum, more common in females.
- Urethral lesions with fistulae.

Constitutional symptoms may be fever and body-aches.

DIAGNOSIS

Skin sensitivity test, called 'Frei's test', is carried out using 0.1 ml Frei's antigen; if positive, a papule, 0.5 cm in diameter, develops after 48 hours. Its positivity is less than 70 percent.¹

EPIDEMIOLOGY

Occurrence is worldwide, more so in tropics and subtropics. It is caused by *Chlamydia trachomatis* of immunotypes L-1, L-2 and L-3. It is akin to the organisms of Trachoma and Inclusion Conjunctivitis (TRIC agents). There has been an increase in the

incidence of this disease in India. Two to three decades ago, it was more or less confined to the Southern states of India, but has now travelled North as well.¹ It is transmitted by direct contact with open lesions of infected persons, usually during sexual intercourse. Incubation period is 7 to 12 days but may be longer, up to 21 days.

TREATMENT

Sulpha drugs, as in case of chancroid. Oxy and chlor-tetracycline 1 g daily in divided doses for 10 days are also effective.

Granuloma Inguinale (Donovanosis) (ICD-A55)

CLINICAL FEATURES

The lesions appears on the genitals as a hard papule or vesicle that ulcerates. The floor of the ulcer is painless, with red velvety granulations. The edge is overlapping and rolled out. It is auto-inoculable and new lesions occur which may coalesce with the old ones to form a wider lesion. Extragenital lesions occur on warm and moist surfaces such as the folds between scrotum and thighs or labia and vagina. Diagnosis is made by demonstrating the causative organisms and by biopsy.

EPIDEMIOLOGY

This disease was seen exclusively in South India two decades ago, but now cases are seen in the North also. In two studies in the early seventies in Delhi, Donovanosis accounted for 3.5 and 7.6 percent of the STD cases respectively. The male and female ratio was 3:2 and the infection was demonstrated in spouses of 40 percent of the married cases.¹ The disease is caused by *Calymmatobacterium granulomatis*, also referred to as *Donovania granulomatis* after Major Donovan, who discovered the causative organisms (Donovan bodies) in India in 1905. Transmission presumably occurs by direct contact with lesions during sexual activity.

INCUBATION PERIOD

Unknown, probably between 8 and 80 days.

SPECIFIC TREATMENT

Tetracycline 500 mg four times daily for 10 days. Cotrimoxazole and chloramphenicol are also effective. Recurrence may occur, but responds to a second course of therapy.¹⁰

STD CONTROL ON A LARGE SCALE

The control measures may be discussed¹⁶ under four headings:

- Planning
- Intervention strategies
- Health and social support
- Monitoring and evaluation.

PLANNING

The phase of planning is very important to balance the needs with resources. This will include defining the extent of the disease, prioritising the various options available, setting of goals, objectives and targets and identifying the appropriate mix of strategies in a given condition.

INTERVENTION STRATEGIES

The patient does not come forward for treatment because STD is related to sexual intercourse. He often feels guilty and hesitant and takes no, insufficient, or quack medicines. Among intervention strategies, the most important step for control of STDs is finding of cases and rendering them noninfectious by adequate treatment.

Case Detection

- *High risk groups:* These are identified and screened for the presence of STD. Cases among prostitutes and call girls may be found in brothels, and red-light areas. Interrogation, search, interviews, some persuasion or even coercion may be necessary to detect them. STD nurses and social workers have to use their skills to prepare the suspects for medical examination and serological tests. Serological surveys may be done in antenatal clinics, hospitals and institutions such as police, defence forces, factories, remand homes and reformatories.
- *Contact tracing:* Conjugal partners must be located, examined and treated. This may present a challenge to the ingenuity of the STD social worker.
- *Cluster testing:* Once the patients are identified, they are asked to name other persons moving in similar socioeconomic and sexual environment, who are then screened for STD.

Treatment

Confidential and free diagnostic as well as treatment services should be available to all cases and contacts. Advice should be made available by post as well. Separate arrangements should be made for males and females. Special centers should be provided to treat prostitutes. Prophylactoria and treatment centers should be conveniently situated where frank cases and those just exposed can get treatment day and night without disclosing their identity. The latter approach, i.e. administration of full therapeutic dose of treatment to those recently exposed to STD even before getting the results of investigation, is referred to as epidemiological treat-

ment or contact treatment and is highly effective in control of STD.^{11,14}

Prophylaxis

Mechanical barrier methods of contraception, such as the condom, are effective methods of personal prophylaxis against STD. The exposed parts should be washed with soap and water immediately after contact. At present there are no vaccines available.

Health Education

The objective of health education at this stage is to help the affected individual to alter his behavior.

HEALTH AND SOCIAL SUPPORT

STD Clinic

Establishment of STD clinics capable of providing all the intervention strategies specified above, including consultation, investigation, treatment and contact tracing, is a very important starting point. These clinics should be attached to every major health and training facility. The clinic should provide free and confidential services.

Integration of STD Control into Primary Health Care Information System

For effective program planning, coordination, monitoring and evaluation, the STD treatment centres and all health facilities should provide the relevant data to a central information network created for this purpose.¹⁶

Control of Prostitution

Abolition of prostitution is not possible. Some countries have legalized prostitution. In India, it is sought to be controlled under the Immoral Traffic (Prevention) Act, 1956.

Social Welfare Measures Including Health Education

Young people should be given proper sex education, including elements of anatomy and function of reproductive organs and sex hygiene. A clear idea of healthy sex-life should be imparted to them and they should be told about dangers of promiscuity. Marriage counseling and sex guidance centers should be established for confidential advice by contact and through post. Unhappy and strained married life leads to extramarital intercourse, thus increasing the chance of exposure to STD. People should be told that it is not a sin to get the disease but it is so to hide it and remain untreated.

MONITORING AND EVALUATION

Monitoring and evaluation is a critical management tool to provide a measure of program effectiveness. Appropriate changes in program strategies may have to be made depending upon the results of evaluation.

National STD Control Program

The STD Control Program started in India as a pilot project in 1949. In 1957 a Central VD organization was set up in the Directorate General of Health Services. This organization coordinated the STD Control Program all over the country. The program operated with 100 percent assistance from the Center. It had the following main components:

- Teaching and training
- Research
- Community education
- Epidemiology.

The program was operated on a regional or zonal basis with the regional STD Teaching cum Training Centers having been established at Delhi, Chennai, Hyderabad, Kolkata and Nagpur. At these institutions, the Regional STD reference laboratories and Regional survey cum-mobile STD centers have also been established. The control of STD now forms part of the National AIDS Control Program described follow.

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Acquired Immunodeficiency Syndrome (AIDS) [ICD-B24]

AIDS is the end result that occurs several years after infection with HIV (Human Immunodeficiency Virus). The disease was detected for the first time in USA in 1981 and the name AIDS was coined next year.

Occurrence

According to WHO,¹ the HIV/AIDS pandemic is growing at alarming pace. This is evident from the number of persons having HIV infection and AIDS (**Table 18.10**).

New data show global HIV prevalence, the percentage of people living with HIV has levelled off and that the number of new infections has fallen, in part as a result of the impact of HIV programs. Though, the total number of people living with HIV is increasing because of ongoing acquisition of HIV infection, combined with longer survival times, in a continuously growing general population. In 2007, 33.2 million (30.6–36.1 million) people were estimated to be living with HIV, 2.5 million (1.8–4.1 million) people became newly infected and 2.1 million (1.9–2.4 million) people died of AIDS. There were an estimated 1.7 million (1.4–2.4 million) new HIV infections in SubSaharan Africa in 2007—a significant reduction since 2001. However, the region remains most severely affected. An estimated 22.5 million (20.9–24.3 million) people living with HIV, or 68 percent of the global total, are in sub-Saharan Africa. Eight countries in this region now account for almost one-third of all new HIV infections and AIDS deaths globally. In Asia, the estimated number of people living with HIV in Viet Nam has more than doubled between 2000 and 2005 and Indonesia has the fastest growing epidemic.²

Global HIV incidence—the number of new HIV infections per year—is now estimated to have peaked in the late 1990s at over 3 million (2.4–5.1 million) new infections per year, and is estimated in 2007 to be 2.5 million (1.8–4.1 million) new infections, an average of

more than 6 800 new infections each day. This reflects natural trends in the epidemic, as well as the result of HIV prevention efforts. The number of people dying from AIDS-related illnesses has declined in the last two years, due in part to the life prolonging effects of antiretroviral therapy. AIDS is among the leading causes of death globally and remains the primary cause of death in Africa.

The single biggest reason for the reduction in global HIV prevalence figures in the past year was the recent revision of estimates in India after an intensive reassessment of the epidemic in that country. The revised estimates for India combined with important revisions of estimates in five SubSaharan African countries (Angola, Kenya, Mozambique, Nigeria, and Zimbabwe) account for 70 percent of the reduction in HIV prevalence as compared to 2006 estimates.² In countries that are most heavily affected, the epidemic has led to a significant increase in household poverty and reduction of life expectancy by more than 20 years.³

PROBLEM STATEMENT IN INDIA

At the beginning of 1986, despite over 20,000 reported AIDS cases worldwide, India had no reported cases of HIV/AIDS. Later in the year, India's first cases of HIV were diagnosed among sex workers in Chennai, Tamil Nadu. It was noted that contact with foreign visitors had played a role in initial infections among sex workers and as HIV screening centers were set up across the country there were calls for visitors to be screened for HIV. Gradually, these calls subsided as more attention was paid to ensuring that HIV screening was carried out in blood banks.⁴ At present, India has the third largest number of HIV positive persons. About 2.5 million people in India, aged between 15 and 49, are estimated to be living with HIV/AIDS, the third largest in the world. HIV/AIDS prevalence rate in the country is 0.36 percent.⁵ While this may seem a low rate, because India's population is so large, it is third in the world in terms of greatest number of people living with HIV. With a population of around a billion, a mere 0.1 percent increase in HIV prevalence would increase the estimated number of people living with HIV by over half a million.

By the end of 2008 there were 4817 ICTCs in India. In 2007 these centers tested 5.9 million people for HIV, an increase from 0.14 million in 2001.⁶

In India, women are becoming increasingly vulnerable to HIV/AIDS and account for about 1 million cases.⁵ The average HIV prevalence among women attending antenatal clinics in India is 0.48 percent. Much higher rates are found among people attending STD clinics (3.6%), female sex workers (5.1%), injecting drug users (7.2%) and men who have sex with men (7.4%).⁷ The National Family Health Survey, which tested more than 100,000 people for HIV, also found

Table 18.10: Global summary of the AIDS epidemic (December 2008)

Number of people living with HIV in 2008	
Total	33.4 million
Adults	31.3 million
Women	15.7 million
Children < 15 years	2.1 million
People newly infected with HIV in 2008	
Total	2.7 million
Adults	2.3 million
Children < 15 years	430 000
AIDS-related deaths in 2008	
Total	2.0 million
Adults	1.7 million
Children < 15 years	280 000

prevalence to be higher in urban areas (0.35%) than in rural areas (0.25%).⁸ Most HIV infections in India occur through heterosexual transmission. In the north-eastern part of the country, however, injecting drug use is the major cause for the epidemic spread; sexual transmission comes next.⁵

WOMEN AND AIDS

Women constitute the fastest rising population group at risk of HIV infection in USA.⁹ At global level, the proportion of women among HIV infected adults increased from 25 to 40 percent between 1990 and 1993.¹⁰ In 1998 alone 9,00,000 women died globally because of HIV/AIDS.¹¹ Risk factors for heterosexual HIV transmission include the following:⁹

1. Break in mucosal barrier, as found in genital ulcer disease
2. Inflammatory diseases of the genitourinary tract
3. Anatomic factors, such as an intact foreskin, or cervical ectopy
4. Certain sexual practices, such as receptive anal intercourse, and sex during menses
5. Various HIV-1 related factors, such as advanced stage of HIV-1 infection in sex partners.

The chance of HIV-1 transmission from infected mother to her infant is 30 percent in the US and other Western countries, compared to 50 to 60 percent in Africa. The reasons for this difference are not known.⁹ The mechanism of transmission can be threefold: transplacental during pregnancy, through blood at the time of delivery and through breast milk during lactation.

There is clear evidence that human papillomavirus (HPV) infection is more common in HIV-1 infected women and is associated with higher frequency and severity of cervical cancer in them.⁹

INFECTIOUS AGENT

The Human Immunodeficiency Virus (HIV) is classified within the Lenti (slow) Virus Subgroup of a new group of viruses called Retroviruses. It is an RNA virus and utilizes an enzyme called Reverse Transcriptase (RT) to generate complementary DNA upon entry into the host cell. This viral DNA gets integrated in the host genome, causing a life-long infection. Therefore, once infected, the person becomes infected with HIV for life. In course of time, it causes AIDS. However, the simian bovine and feline immunodeficiency viruses are found in animals without causing disease.

There are two types of HIV namely HIV-1 and HIV-2. Of these, HIV-1 is more lethal. It is widespread in Europe, Asia, Africa and the American continent. Strain HIV-2 is similar to Simian Immunodeficiency Virus (SIV) found in monkeys. It is found in West Africa.

Nine subtypes of HIV-1 and four of HIV-2 have been isolated so far. Of these only five occur in epidemic form. The most common subtype found in India is HIV-1 subtype C (primarily heterosexual transmission). However, HIV-1 subtype B is also found in drug users in India. The most common subtype in Thailand is HIV-1 E and in US and Europe HIV-1 B. The HIV-1 C strain proliferates well in penile and vaginal Langerhans' cells. Hence it is ideal for heterosexual transmission. It is transmitted 5 to 10 times more effectively than the HIV-1 B strain prevalent in Western Europe and North America. The implication of this difference is that when an HIV infected person has sex with an uninfected woman for the first time, the chance of the woman getting infected will be 5 to 10 percent in India or Southern and Eastern Africa, but only 0.5 to 1 percent in Western Europe or North America.

Immunity

There is some evidence of immunity to HIV in certain populations. In a large study of commercial sex workers in Nairobi and Zambia, it was observed that 10 to 15 percent women escaped infection initially. In persons with good immunity, infection was limited to local lymph nodes. The nature of such immunity is not clear. It may be due to a genetically better immune response. Alternatively, it may be due to lower doses of infection being presented in an optimal way.

Immunopathology

The two main targets of HIV are (1) the helper (CD4+) lymphocyte, a cell which is central to the normal functioning of the immune system, and (2) the microglial cells, and macrophage cells in the central nervous system. Attack on these cells leads to:

- Cellular type of immunodeficiency causing susceptibility to opportunistic infections of various types and rare opportunistic cancers.
- Central nervous system disease.

The HIV can infect several other cells of the body, including the gut epithelial cells causing an enteropathy, renal glomerular cells causing kidney disease, several bone marrow cells and the cells of many other organs of the body. Thus it is truly a generalised infection of the human body.

ROLE OF COFACTORS

After entering the genome of the host cells, the viral DNA (called provirus) remains dormant for long periods. But, infection with cytomegalovirus and herpes simplex virus, as also gonorrhoea and syphilitic infections, may be playing important role in activating the dormant provirus into a rapidly replicating one.

Once a large number of viral particles are produced, they lyse the host cells, producing the immunopathological damage recognized clinically as HIV disease.¹²

MODES OF TRANSMISSION

The only known modes of transmission of HIV are:

- Heterosexual, homosexual and bisexual routes.
- Parenteral route via contaminated needles and other skin piercing instruments.
- Through transfusion of contaminated blood and blood products.
- Transplacentally or perinatally from HIV infected woman to her newborn baby.

It is well known that the chances of contracting AIDS sexually increase rapidly with increasing number of partners and number of intercourses. Homosexual (anal) intercourse is supposed to have higher risk of HIV transmission than heterosexual (vaginal) intercourse.

Transfusion with one contaminated unit of blood has 90 percent chance of infecting the recipient. A contaminated needle has about 0.5 percent chance of transmitting the infection. The chance of transplacental infection in the newborn is 30 to 50 percent. However, it is variable, depending upon the clinical stage and condition of the mother: women with clinical HIV illness would have very high chance of infecting the newborn transplacentally (about 70%) than those with asymptomatic infection (about 10%).

In rare circumstances breast milk may also transmit HIV infection. But, the benefits of breastfeeding far outweigh the risk of HIV infection. Therefore, as a policy, the WHO recommends breastfeeding unless the mother is obviously, clinically ill. In view of the prevalent scare about AIDS infection in the public and the medical profession alike, it is important to remember that AIDS/HIV infection is not transmitted by social and casual contact.

AIDS virus is present in large amounts in semen, vaginal secretions, cerebrospinal fluid (CSF) and blood of the patients. It has also been demonstrated in pre-ejaculatory fluid of infected males.¹³ Other body fluids and secretions of an HIV infected person have only negligible amounts of the virus and are of no practical relevance. Extensive epidemiological studies have shown that only blood, semen, vaginal secretions, cerebrospinal fluid (CSF) and possibly, breast milk are involved in the transmission of HIV infection. Mosquitoes or other blood sucking insects do not transmit HIV infection.

HIV has occasionally been found in saliva, tears, urine and bronchial secretions. However, transmission after contact with these secretions has not so far been reported. Following contamination with infected blood because of injury with needles or other sharp objects, the rate of seroconversion is less than 0.5 percent in case of HIV compared to 25 percent in case of HBV.¹⁴

EFFICIENCY OF DIFFERENT ROUTES OF TRANSMISSION

- Blood transfusion – most common (90–95%)
- Perinatal transmission (20–40%)
- Sexual intercourse (0.1–1.0%)
- Vaginal (0.05–0.1%)
- Anal (0.05–0.5%)
- Oral (0.005–0.01%)
- Intravenous drug users (0.7%)
- Needle stick (0.3%)
- Mucous membrane splash to eye, oronasal (0.09%)

AT RISK PEOPLE

Annual Sentinel Surveillance data (2003 to 2005) shows that female sex workers (FSWs), men having sex with men (MSM) and injecting drug users (IDUs) have disproportionately higher incidence of HIV infection. Whereas HIV prevalence in the general population is 0.88 percent, its prevalence among FSWs is 8.44 percent, IDUs 10.16 percent, MSM 8.74 percent and among the attendees of STD clinics it is 5.66 percent.¹⁵

FACTORS FAVORING SPREAD OF HIV

- Low literacy level
- Gender disparity
- Unprotected commercial sex and casual sex with multiple or nonregular partners
- Certain traditional belief and practices
- Poverty and migration
- Stigma leading to poor communication and marginalisation of infected persons.

NATURAL HISTORY

When specific antiviral therapy against HIV was not available, follow-up cohort studies of HIV infected persons revealed that: (a) 15 percent developed AIDS within first 5 years, (b) Another 30 to 35 percent developed AIDS within next 2 to 5 years, (c) Most of the remaining developed AIDS within next 5 to 10 years.¹⁴ The onset of AIDS may be delayed with the use of specific antiviral treatment.

CLINICAL FEATURES

It is important to keep in mind that the clinical features of AIDS acquire special importance when the person belongs to one of the high risk groups mentioned earlier. This is important to remember because many of the clinical features of HIV clinical disease are nonspecific, often seen in several other common conditions.

Being a slow virus, HIV produces slowly progressive damage of the target tissues, namely, the immune system and the central nervous system. During the slow life-cycle of HIV infection the following clinical stages may be recognizable.¹²

Acute Seroconversion Illness

In about 15 percent of the persons getting HIV infection, an acute viral illness develops about 6 weeks after the entry of the virus into the body. Clinically it resembles infectious mononucleosis (glandular fever) with high fever, skin rash, headache, muscle pains, joint pains and enlarged lymph nodes in the neck and axillae. Encephalitis and aseptic meningitis can also occur. On an average, the illness clears up within 2 weeks. If tested for HIV, the person would show a positive serological test during the recovery phase, hence the name “seroconversion illness.”

Asymptomatic Carrier Stage

After acute seroconversion stage, the individual become asymptomatic and remain in this stage for long periods (average 7 to 9 years). But the person is fully infectious during this stage and is capable of spreading the disease through his blood and body fluids.

Persistent Generalized Lymphadenopathy (PGL) Syndrome

Some asymptomatic persons infected with HIV develop big lymph glands in their neck and axillae for no obvious reasons. These glands may persist for months without any change. This rather stable clinical stage in HIV illness is called PGL syndrome.

AIDS Related Complex (ARC) and HIV Constitutional Disease

On an average, 7 to 9 years after infection with HIV, the seropositive individuals start developing recurrent bouts of diarrhea, night sweats, fever and weight loss. This clinical stage is identified as ARC. Some of these individuals may also develop minor opportunistic infections like oral candida (thrush). This clinical stage of ARC associated with minor opportunistic infections is identified as “constitutional disease”. This clinical stage heralds the onset of the terminal phase of HIV illness.

“Full Blown” AIDS

Within a few months of ARC, the immune system of the HIV infected person undergoes further deterioration. The CD4+ cells fall below 200 per cmm. At this stage these patients start showing severe and life-threatening opportunistic infections. These include:

- *Fungal infections: Candida, Histoplasma, Cryptococcus*
- *Protozoal infections: Pneumocystis carinii, Cryptosporidium isospora, Toxoplasma*
- *Bacterial infections: Typical and atypical mycobacterial infections, Salmonella, Shigella*
- *Helminthic infections: Generalized strongyloidosis.*

These persons may also show opportunistic cancers including:

TABLE 18.11: Common infections at different CD4 levels

CD4 Cell Count	Common Clinical Features
150 to 500/ml	Oral and vaginal candidiasis, oral hairy leukoplakia, sinusitis, gingivitis, seborrheic dermatitis, psoriasis, warts, molluscum contagiosum, recurrent varicella-zoster and herpes simplex infection, cervical dysplasia, tuberculosis, fever, sweats, weight loss
< 150/ml	<i>Pneumocystis jiroveci</i> pneumonia, Kaposi's sarcoma, oesophageal candidiasis, cerebral toxoplasmosis, lymphoma, HIV dementia, cryptococcal meningitis
< 50/ml	<i>Cytomegalovirus</i> retinitis, cerebral lymphoma, <i>Mycobacterium avium</i> complex infection

- Generalized and aggressive form of Kaposi's sarcoma
- High grade B-cell lymphoma of the brain.

Central Nervous System HIV Disease

During the terminal stages of the illness the CNS also gets involved. The following CNS diseases caused by HIV are known:

- *AIDS dementia complex:* It consists of clumsiness and slowing down of movements, disturbances in thought process, memory judgment and behavioral abnormalities.
- *AIDS myelopathy:* It is a special type of spinal cord damage (vacuolar myelopathy) with a form of sensory-motor paralysis.
- *AIDS neuropathy:* It causes severe pins and needles sensation on the tips of fingers and toes.

Common Infections at Different CD4 Levels

The degree of immune suppression (measured as the CD4 cell count) predisposes to the development of certain illnesses. Tuberculosis is the only opportunistic infection that may appear at any CD4 level (**Table 18.11**).¹⁶

DIAGNOSIS

Testing for HIV

Testing without explicit consent may prove counter productive and has put people away from HIV testing and it is also violation of human rights. Complete procedure consists of four stages.

A. Pretest counseling

1. Impairing awareness on how infection is acquired, different risk factors and its prevention.
2. Explaining implications of positive or negative results.
3. Explaining window period.
4. Obtaining informed consent.

B. HIV testing

Selection of tests depends upon objective of testing and sensitivity of test.

For surveillance: Two tests are using different antigens; if two tests are positive then HIV antibody is considered to be present. This policy is maintained in antenatal clinic, STD clinic and intravenous drug users sites.

In blood bank, if the blood is positive with one antigen then it is considered positive. Blood is discarded and donor traced.

For symptomatic or asymptomatic client:

Here three tests are being done using three different antigens.

If the first test is reactive, then only second and third tests are performed. When all the three tests are reactive, then HIV antibody is considered positive.

When signs and symptoms suggestive of HIV infection, then two positive tests are sufficient for diagnosis.

C. Post-test counseling

If the test is positive, then the patient is referred for CD₄ testing and ART initiation. In addition counselling is done regarding resources and treatment available.

If the test is negative, then the client is counselled to decrease the risk behavior and resources available to support behavioural changes.

D. Follow-up counseling

This is recommended irrespective of results in subsequent follow up visits.

HIV Testing of TB Patients

Central TB Division (CTD) and the National AIDS Control Organization (NACO) have adopted the policy of routinely offering voluntary HIV counseling and testing to all TB patients as part of an intensified TB/HIV package of services. This policy will facilitate early detection of HIV infection in TB patients, and lead to early access to HIV care and treatment. These interventions are expected to reduce death and disease among HIV-infected TB patients.¹⁷

LABORATORY DIAGNOSIS

1. Serology

This is the mainstay of diagnosis of HIV infection.

a. Antibody tests: ELISAs are the most frequently used method for screening of blood samples for HIV antibody, whose sensitivity and specificity approaches 100 percent but false positive and false negative reactions do occur. The ELISA test can detect IgM or IgA. Other test systems available include passive particle agglutination, immunofluorescence, Western blots and RIPA bioassays. Western blots are regarded as the gold standard and seropositivity is diagnosed when antibodies against both

the env and the gag proteins are detected. This test has higher specificity but costlier than ELISA.

b. Antigen tests: Early in the course of HIV infection before the appearance of antibody, HIV antigen can be detected during the latent period. However, its benefit is questionable.

2. Virus Isolation

This is done by the cocultivation of the patient's lymphocytes with fresh peripheral blood cells of healthy donors or with suitable culture lines such as T-lymphomas or by measurement of p24 antigen. The presence of the virus can be confirmed by reverse transcriptase assays, serological tests or by changes in growth pattern of the indicator cells. This test is mainly reserved for the characterization of the virus.

3. Demonstration of Viral Nucleic Acid

This test is done by probes or by Polymerase Chain Reaction (PCR) techniques. PCR is based on the concept of a specific nucleic acid sequence, such as HIV proviral DNA, that can be amplified by repetitive DNA synthesis to levels that can be easily detected.

4. Prognostic Tests

These are the tests used for monitoring the response to treatment thus have prognostic values - (i) HIV antigen (ii) Serial CD4 counts (iii) Neopterin (iv) B₂-microglobulin and (v) Viral load. Of these tests, only serial CD4 counts and HIV viral load are routinely used.

a. HIV viral load: It appears that HIV viral load has the greatest prognostic value. HIV viral load in serum may be measured by assays which detect HIV-RNA e.g. RT-PCR, NASBA, or bDNA. Patients having low pre-treatment and after-treatment viral load have good prognosis.

b. CD4 counts: CD4 count gives an indication of the stage of disease and gives an idea about disease progression and response to antiviral chemotherapy.

Viral load level indicates the magnitude of HIV replication while CD4 counts indicate the extent of HIV induced immune damage.

5. Antiviral Susceptibility Assays

There are two types of antiviral susceptibility assays: phenotypic and genotypic assays. **Phenotypic assays** demonstrate whether a particular strain of virus is sensitive or resistant to an antiviral agent by determining the concentration of the drug needed to inhibit the growth of virus *in vitro*, e.g. plaque-reduction assay for HSV, plaque-reduction assay for HIV. Phenotypic assays are applicable for viruses that can be cultivated.

On the other hand, mutations that are associated with drug resistance are being studied in **genotypic assays**; which is being conducted by molecular biology methods such as PCR and LCR.

However, these assays are tedious and are not recommended for a routine laboratory diagnosis. Moreover, the results of genotypic assays may prove very difficult to interpret, since HIV mutates at a furious pace, and it is also possible that resistant strains are present right at the beginning of infection.¹⁸

Interpretation of anti-HIV antibody test in the newborn: Due to the passive transplacental transfer of maternal antibodies, a newborn may give a “false positive” ELISA and WB test even if he is not infected with HIV. It may take up to 15 to 18 months before maternal antibodies disappear completely.

More reliable diagnosis of real HIV infection in infants can be made by the following means:

- PCR test.
- Detection of anti-HIV IgM and IgA antibodies which do not cross the placental barrier.
- Viral culture.

AIDS

50 percent HIV infected persons develop AIDS within 7 to 10 years. The WHO has already standardized a staging system for AIDS patients for clinical management and research purposes.¹⁹

WHO case definitions for AIDS for surveillance purposes are given below. These are of two types.²⁰

WHO CASE DEFINITION FOR AIDS SURVEILLANCE (IRRESPECTIVE OF THE TEST)

For the purposes of AIDS surveillance an adult or adolescent (>12 years of age) is considered to have AIDS if at least two of the following major signs are present in combination with at least one of the minor signs listed below, and if these signs are not known to be due to a condition unrelated to HIV infection.

Major signs

- Weight loss ≥ 10 percent of body weight
- Chronic diarrhea for more than 1 month
- Prolonged fever for more than 1 month (Intermittent or constant).

Minor signs

- Persistent cough for more than 1 month^a
- Generalized pruritic dermatitis
- History of herpes zoster
- Oropharyngeal candidiasis
- Chronic progressive or disseminated herpes simplex infection
- Generalized lymphadenopathy.

The presence of either generalized Kaposi’s sarcoma or cryptococcal meningitis is sufficient for the diagnosis of AIDS for surveillance purposes.

Advantages of the WHO case definition for AIDS surveillance are that it is simple to use and inexpensive

since it does not rely on HIV serological testing. Limitations of this case definition are its relatively low sensitivity and its low specificity particularly with respect to tuberculosis, since HIV-negative tuberculosis patients could be counted as AIDS case because of their similarity in clinical presentation.

Expanded WHO Case Definition for AIDS Surveillance (With Positive HIV Test)

For the purposes of AIDS surveillance an adult or adolescent (>12 years of age) is considered to have AIDS if a test for HIV antibody gives a positive result, and 1 or more of the following conditions are present:

- ≥ 10 percent body weight loss or cachexia, with diarrhea or fever, or both, intermittent or constant, for at least one month, not known to be due to a condition unrelated to HIV infection
- Cryptococcal meningitis
- Pulmonary or extrapulmonary tuberculosis
- Kaposi’s sarcoma
- Neurological impairment that is sufficient to prevent independent daily activities, not known to be due to a condition unrelated to HIV infection (for example, trauma or cerebrovascular accident)
- Candidiasis of the esophagus (which may be presumptively diagnosed based on the presence of oral candidiasis accompanied by dysphagia)
- Clinically diagnosed life-threatening or recurrent episodes of pneumonia, with or without etiological confirmation
- Invasive cervical cancer.

Major features of this expanded surveillance case definition are that it requires an *HIV serological test*, and includes a broader spectrum of clinical manifestations of HIV such as tuberculosis, neurological impairment, pneumonia, and invasive cervical cancer. The expanded definition is simple to use and has a higher specificity than the WHO case definition for AIDS surveillance. A disadvantage is that it requires the availability of HIV serological testing for clinical diagnostic purposes, which may be logistically difficult and costly (**Table 18.12**).

METHODS OF CONTROL¹⁴

Preventive Measures

- Sexual discretion: Sexual promiscuity should be avoided. Anal sex, multiple sex partners and sex with persons infected or suspected to have AIDS should be avoided or minimized.
- Blood and blood products should be kept free from AIDS infection. Till the laboratory test procedures for this purpose are well established, an important step in this direction will be discouraging persons belonging to high AIDS risk groups from donating blood.

^a For patient with tuberculosis, persistent cough for more than 1 month should not be considered as a minor sign

TABLE 18.12: WHO clinical staging of HIV/AIDS for adults and adolescents, 2006*

Clinical stage 1
<ul style="list-style-type: none"> • Asymptomatic • Persistent generalized lymphadenopathy
Clinical stage 2
<ul style="list-style-type: none"> • Unexplained moderate weight loss (<10% of presumed or measured body weight)¹ • Recurrent respiratory tract infections (sinusitis, tonsillitis, otitis media, pharyngitis) • Herpes zoster • Angular cheilitis • Recurrent oral ulceration • Papular pruritic eruptions • Seborrheic dermatitis • Fungal nail infections
Clinical stage 3
<ul style="list-style-type: none"> • Unexplained² severe weight loss (>10% of presumed or measured body weight) • Unexplained chronic diarrhea for longer than one month • Unexplained persistent fever (above 37.5°C intermittent or constant for longer than one month) • Persistent oral candidiasis • Oral hairy leukoplakia • Pulmonary tuberculosis • Severe bacterial infections (e.g. pneumonia, empyema, pyomyositis, bone or joint infection, meningitis, bacteremia) • Acute necrotizing ulcerative stomatitis, gingivitis or periodontitis • Unexplained anemia (<8 g/dl), neutropenia (<0.5 × 10⁹/liter) and or chronic thrombocytopenia (<50 × 10⁹/liter³)
Clinical stage 4³
<ul style="list-style-type: none"> • HIV wasting syndrome • Pneumocystis pneumonia • Recurrent severe bacterial pneumonia • Chronic herpes simplex infection (orolabial, genital or anorectal of more than one month's duration or visceral at any site) • Esophageal candidiasis (or candidiasis of trachea, bronchi or lungs) • Extrapulmonary tuberculosis • Kaposi sarcoma • Cytomegalovirus infection (retinitis or infection of other organs) • Central nervous system toxoplasmosis • HIV encephalopathy • Extrapulmonary cryptococcosis including meningitis • Disseminated nontuberculous mycobacteria infection • Progressive multifocal leukoencephalopathy • Chronic cryptosporidiosis • Chronic isosporiasis • Disseminated mycosis (extrapulmonary histoplasmosis, coccidiomycosis) • Recurrent septicemia (including nontyphoidal salmonella) • Lymphoma (cerebral or B cell non-Hodgkin) • Invasive cervical carcinoma • Atypical disseminated leishmaniasis • Symptomatic HIV-associated nephropathy or symptomatic HIV-associated cardiomyopathy

¹Assessment of body weight in pregnant woman needs to consider expected weight gain of pregnancy.

²Unexplained refers to where the condition is not explained by other conditions.

³Some additional specific conditions can also be included in regional classifications (e.g. reactivation of American trypanosomiasis (meningoencephalitis and/or myocarditis) in Americas region, Penicilliosis in Asia)

Source: Antiretroviral Therapy Guidelines for HIV-infected Adults and Adolescents Including Postexposure Prophylaxis. May 2007. NACO, National AIDS Control organization. Ministry of Health and Family Welfare. Government of India.

TABLE 18.13: Different classes of ARV drugs

Nucleoside reverse transcriptase inhibitors (NRTI)	Nonnucleoside reverse transcriptase inhibitors (NNRTI)	Protease inhibitors (PI)
Zidovudine (AZT/ZDV) Stavudine (d4T) Lamivudine (3TC) Didanosine (ddl) Zalcitabine (ddC) Abacavir (ABC) Emtricitabine (FTC)	Nevirapine (NVP) Efavirenz (EFV) Delavirdine (DLV)	Saquinavir (SQV) Ritonavir (RTV) Nelfinavir (NFV) Indinavir (INV) Amprenavir (APV) Lopinavir/Ritonavir (LPV) Foseamprenavir (FPV) Atazanavir (ATV) Tipranavir (TPV)
	Fusion inhibitors (FI)* Enfuvirtide (T-20)	
Nucleotide reverse transcriptase inhibitors (NtRTI) Tenofavir (TDF)	CCR5 Entry Inhibitor (new)	Integrase Inhibitors (new)

* Block binding of HIV to target cells.

- Blood transfusions should be given only when strictly indicated.
- Hemophiliacs should be given heat treated preparations instead of coagulation factor concentrates.
- Appropriate health education should be given to public and to school and college students.
- Treatment facilities for drugs users should be expanded to include AIDS related health education, particularly as regards use of safe needles.
- Free and anonymous or confidential HIV testing, counselling and referral services should be routinely made available at places such as (i) STD clinics, (ii) Drug treatment clinics, (iii) Antenatal clinics, (iv) Family planning centers, (v) Facilities for gay men, prostitutes and hijras (eunuchs), and (vi) Communities or places frequented by persons at high risk of HIV infection (such as high way resting points for truck drivers).
- Health care workers should be careful in handling needles, sharp instruments and blood. Latex gloves should be used whenever one has to handle blood or fluids that are visibly bloody. If patient's blood comes in contact with the health worker's skin, it should be immediately washed away with soap and water.

Control of Patients, Contacts and the Immediate Environment

- Report to health authorities.
- *Isolation*: Precautions should be taken to avoid contact with blood and body fluids of the patient.
- Concurrent disinfection of all equipment of contaminated with blood, all excretions and secretions of the patient.¹⁴
- *Quarantine*: None. But HIV infected persons and their sex partners should not donate blood for transfusion, semen for artificial insemination and body organs for transplantation.¹⁴
- *Immunization of contacts*: None
- *Investigation of contacts*: Not feasible as a routine.
- *Specific treatment*: The currently available antiretroviral drugs can not cure HIV infection,

TABLE 18.14: ART criteria for adults and adolescents:

WHO clinical stage	CD4 count (cells/mm ³)
I	Treat if CD4 count < 250 (If between 251 – 300,
II	Repeat CD4 count after 4 weeks)
III	Treat if CD4 count < 350
IV	Treat irrespective of CD4 count

Specific situations

- **HIV and tuberculosis** (start efavirenz based regimen)
 - Pulmonary TB and HIV: Start ART within 2 weeks of initiation of ATT for all patients with CD4 < 350 cells/mm³ (For patients CD4 > 350, defer ART)
 - Extrapulmonary TB and HIV: Start ART within 2 weeks of initiation of ATT in all patients irrespective of CD4 count (Monitor hepatotoxicity).
- **HIV and pregnancy** (avoid efavirenz in first trimester)
 - WHO stage I and II: Start ART at CD4 < 250 cells/mm³ (If between 251–300, repeat CD4 after 4 weeks).
 - WHO stage III: Start ART at CD4 < 350 cells/mm³ (Strictly monitor adverse effects of nevirapine).
 - WHO stage IV: Start ART irrespective of CD4 count.

because a pool of latently infected CD4 cells are established during the earliest stages of acute HIV infection and persists with a long half-life, even with prolonged suppression of plasma viremia to <50 copies/ml (**Table 18.13**).

Antiretroviral therapy (ART) effectively suppresses replication, if taken at the right time. Successful viral suppression restores the immune system and halts onset and progression of disease as well as reduces chances of getting opportunistic infections. It also reduces the risk of sexual transmission, mother to her child transmission (MTCT), transmission after an accidental needle stick injury and in cases of sexual assault and rape etc. Medication thus enhances both quality of life and longevity (**Table 18.14**).

Adherence to ART regimen (Highly active antiretroviral therapy–HAART) is therefore very vital in this treatment. Any irregularity in following the prescribed regimen can lead to resistance to HIV drugs, and therefore can weaken or negate its effect.

TABLE 18.15: Recommended first-line antiretroviral regimens

Recommendation	Regimen	Comments
Preferred first-line regimen	Zidovudine + Lamivudine + Nevirapine *	AZT may cause anaemia, which requires Hb monitoring, but is preferred over d4T because of d4T toxicity (lipoatrophy, lactic acidosis, peripheral neuropathy) Patients who develop severe anemia while on an AZT-based regimen should not be re-challenged with AZT. In such cases, the patient should receive either d4T or TDF in place of AZT For women with CD4 > 250 cells/mm ³ , monitor for hepatotoxicity closely if started on the NVP-based regimen
Alternative first-line regimens	Zidovudine + Lamivudine + Efavirenz	EFV is substituted for NVP in cases of intolerance to the latter or if patients are receiving rifampicin-containing anti-TB treatment EFV should not be used in patients with grade 4 or higher elevations of ALT
	Stavudine + Lamivudine + (Nevirapine or efavirenz)	If the patients have anemia, a d4T-based regimen should be prescribed
Other options	Tenofovir disoproxil fumarate + Lamivudine + (Nevirapine or efavirenz) or Zidovudine + Lamivudine + Tenofovir (TDF)	TDF is supplied on a case-to-case basis by SACS after evaluation by the SACS clinical expert panel

* Substitute NVP with EFV, for patients with TB or toxicity to NVP.

TABLE 18.16: Different challenges²⁴

Scientific challenges	Programmatic challenges
Genetic diversity due to env gene.	HIV vaccine clinical trial are long, difficult and expensive.
Lack of formation of neutralizing antibody against the globally diverse and circulating strain of HIV.	Recruiting volunteers for the clinical trials are difficult.
Lack of proper animal model for preclinical testing.	Lack of political commitment.

Three principles are being maintained for selecting the first-line regimen: (1) lamivudine is chosen in all regimens, (2) one NRTI (Zidovudine or Stavudine) is chosen to combine with Lamivudine (3) one NNRTI (Nevirapine or efavirenz) is also selected (**Table 18.15**).

Fixed-dose combinations (FDCs) are preferred because they are easy to use, have distribution advantages, improve adherence to treatment and thus reduce the chances of development of drug resistance. The current national experience shows that bid (twice a day) regimens of FDCs are well tolerated and complied with. EFV is contraindicated in pregnant HIV-infected women during the first trimester of pregnancy because of concerns of teratogenicity.

ART is now available free to all those who need it. ART centers are located in medical colleges, district hospitals and non-profit charitable institutions providing care, support and treatment services to people living with HIV/AIDS (PLHA). ART centers also provide counseling and follow-up on treatment adherence and support through community care centers (CCC).

HIV VACCINE

There are three different approaches to HIV vaccination:²¹

1. *Preventive vaccine*: To prevent HIV-negative persons from being infected.

2. *Perinatal vaccine*: To vaccinate HIV-infected pregnant women, in order to protect the fetus or the newborn child from being infected.

3. *“Therapeutic” or post-infectious vaccine*: To delay the progression to AIDS in HIV-positive persons.

Background: The first phase I trial of an HIV vaccine was conducted in 1987 using a gp160 candidate vaccine. Subsequently, more than 30 candidate vaccines have been tested in over 60 phase I/II trials, involving approximately 10,000 healthy volunteers. Most of these trials have been conducted in the USA and Europe, but several have also been conducted in developing countries. The first phase III trials began in the USA in 1998 and in Thailand in 1999 to assess the efficacy of the first generation of HIV vaccines (based on the HIV envelope protein, gp120).²²

An HIV vaccine could either prevent disease onset or progression to AIDS. According to mathematical estimates by the International AIDS Vaccine Initiative (IAVI) – provided that other programs for treatment and prevention have been scaled up – an HIV vaccine with an efficacy as low as 30 percent and coverage as low as 20 percent could avert as many as 5.5 million new infections between the year 2015 to 2030.²³ The development of an effective vaccine has posed a wide range of challenges, as HIV has proven to be a uniquely complex virus.²⁴ An effective vaccine against HIV would

have to elicit protection against both free virus and virus-infected cells (**Table 18.16**).

Types of HIV Vaccines²⁴

Live attenuated vaccine: Although it has been tested in animals with high level of protection; but they are not being developed for use in humans because of safety concerns.

Inactivated vaccine: Because of the serious nature of the disease and the ability of retroviruses to induce latency, it is unlikely that live attenuated or inactivated virus will ever be accepted for human use.

Subunit vaccine: The first AIDS vaccine developed and tested was designed by using the subunit concept. Subunit vaccine (AIDSVAX gp 120) was the first vaccine that underwent complete testing in humans. This vaccine contains small protein or piece of pathogen, which elicits B cell mediated humoral response against the antigen.

Synthetic peptide vaccine: Neutralizing and T cell epitopes are included in this vaccine. The problems with synthetic peptides are related to the tertiary structures which may be different from those of native proteins.

DNA vaccines: This vaccine uses copies of single or multiple genes from the pathogen. The gene from the pathogen integrates with the human gene resulting in the formation of protein that acts as an antigen to produce the antibody. DNA vaccine will not cause HIV infection, since it does not contain all the genes of the live pathogen. Many of the current AIDS vaccine candidates are DNA vaccine.

Recombinant vector vaccines: This adopts a same strategy like DNA vaccines, but except that the genes are carried by a harmless or a much weakened bacterium or virus called vector. Many of the current AIDS vaccine candidates are vector vaccines. Like DNA vaccine, vector vaccine will not cause HIV infection since it contains copies of one or several HIV genes, not all of them. They carry a high immunogenicity since virus replication results in large quantities of virus antigen. Both humoral and cellular immunity can be induced. Some of the candidate recombinant virus vectors include adeno and adeno-associated viruses, pox viruses like Modified Vaccinia Ankara (MVA) and alphaviruses like Venezuelan Equine Encephalitis (VEE) virus. A disadvantage of this approach is possible adverse effects observed after inoculation of vaccinia virus.

Other type of the following approaches has also been studied like anti-idiotypes antibodies and passive immunization. Passive immunization may be helpful for postexposure protection.

Status of AIDS Vaccine

Global scenario

The International AIDS Vaccine Initiative, WHO, UNAIDS and others including vaccine industry are involved in the

development of vaccines. Out of the 24 candidate vaccines in different stages of development, 18 are in phase I trial, 3 are in phase I/II trial, 2 are in phase II trial, and only 1 is in the phase III trial which is VaxGen's gp120 based AIDSVAX that is being tested in Thailand.

Indian scenario

ICMR, NACO, their partner International AIDS Vaccine Initiative (IAVI), Department of Biotechnology (DBT) are involved in vaccine development in India. The Indian HIV vaccine has been designed to prevent HIV 1c subtype. The first ever conducted trial in India was Adenoassociated virus based vaccine expressing gag, protease, delta-RT HIV 1 subtype c gene, given intramuscularly to 30 healthy uninfected adult volunteers. This trial was initiated in February 2005 at National AIDS Research Institute (NARI), Pune and the vaccine was found to be safe, well tolerated and modestly immunogenic. Another phase I trial in Chennai (January 2006) with Modified Vaccinia Ankara (MVA) vaccine suggests safety, tolerability and 100 percent immunogenicity.²⁴

National AIDS Control Program

National AIDS Committee was formed in 1986 and National AIDS Control Program was started in 1987. The activities were HIV screening in sexually promiscuous group and among blood donors along with increased educational activities. Then in 1992 National AIDS Control Organization (NACO) was established as a separate wing by Department of Health, Ministry of Health and Family Welfare. At present, National AIDS Control Program is in its third phase (2007–2012) of activity. The first two phases of activity NACP I (1992–2001) and NACP II (2001–2007) built up the infrastructure required for providing comprehensive services for prevention, care and treatment. India through its National AIDS Control Program stands committed to Millennium Development Goal (MDG) of reversing the spread of HIV/ AIDS by 2015.²⁵

GOALS AND OBJECTIVES OF NACP III

The overall goals of NACP-III is to halt and reverse the epidemic in India over the next five years by integrating programs for **prevention, care and support and treatment** through the following strategies.

- Prevention of infection through saturation of coverage of high-risk groups with targeted interventions (TIs) and scaled up interventions in the general population.
- Provision of greater care, support and treatment to larger number of persons living with HIV and AIDS (PLHA).
- Strengthening the infrastructure, systems and human resources in prevention, care, support and treatment programs at district, state and national levels.

- Strengthening the nationwide Strategic Information Management System for addressing issues of planning, monitoring, evaluation, surveillance and research to help track the epidemic, identify the pockets of infection and estimate the burden of infection.

The specific objective is as follows:

i. For high prevalence state: Reduction of rate of incidence by 60 percent in the first year of the program to achieve the reversal of the epidemic.

ii. For vulnerable state: Reduction of rate of incidence by 40 percent in the first year of the program to stabilise the epidemic.

NACP-III also seeks to promote district-level network of people living with HIV/AIDS. It seeks active role of welfare organizations in providing nutritional support, opportunities for income generation and other welfare activities for HIV positive people.

DIFFERENT STRATEGIES

Targeted Interventions (TI) for High Risk Groups

The high risk groups [commercial sex workers (CSW), men-who-have-sex-with-men (MSM), injecting drug users (IDU), and female sex workers (FSW)] are more vulnerable; and prevention strategies include five elements—behavior change, treatment for sexually transmitted infections (STI), monitoring access to and utilization of condoms, ownership building and creating an enabling environment.

In both rural and urban areas TI focuses on clients of sex workers, partners of MSM and IDUs through peer led interventions by community based organizations (CBO) or NGOs. NGOs/CBOs engaged in TIs are networked and linked to general healthcare facilities to ensure that HRGs access them without stigma or discrimination; they are also linked to Community Care Centers (CCC), Counseling and Testing Centers and ART centers.

Targeted interventions among **female sex workers** bring awareness about health implications of unsafe sex and HIV/AIDS issues through promotion of STI services, condom use, behavior change communication (BCC) through peer and outreach, building enabling environment, ownership building in the community and linking prevention to HIV related care and support services.

Targeted interventions provided among **injecting drug users** are detoxification, deaddiction and rehabilitation, needle exchange, substitution therapy, abscess management and other health services to reduce their vulnerability.

Targeted interventions for **men-who-have-sex-with-men** are use of lubricants and appropriate condoms, behavior change communication (BCC) through peer and outreach, building enabling

environment, and linking prevention to HIV related care and support services.

Interventions among General Population

HIV transmission among general population often occurs through their sexual partners, who also have an infected sexual partner(s) among the high risk groups. Interventions for general population are about raising their awareness of HIV. Among the general population, women, youth and adolescents are more vulnerable.

National AIDS Control Organization (NACO) steers HIV/AIDS prevention, treatment, education, sensitization and control programs in India. It disseminates awareness among various risk groups, adolescents and out-of-school-children through a number of channels and special programs, since awareness can bring behavioral change. Various guidelines, training modules, IEC material, surveillance reports, highly successful awareness programs for high risk groups, etc are being published in NACO website.²⁵ National AIDS helpline has been set up with a **toll free number 1097** for telephonic counseling which maintains privacy and confidentiality of the caller. School health curriculum has been developed in association with NCERT. School and university students have been covered under '**University Talk AIDS project**'. **ABC** (Abstinence, befaithful and Condom) and **CNN** (Condom, Needle exchange and Negotiation) are the two debated approach for control of HIV spread in the world. Every year world AIDS day is celebrated on **December 1** to attract the attention. The **red ribbon** is an international symbol of AIDS awareness. **Red ribbon express** is the name of a train that traverse the country with 7 coaches equipped with educational materials.

SERVICES FOR PREVENTION

The HIV epidemic in India is spreading to the general population from high risk groups (sex workers, men-having-sex-with-men, injecting drug users and clients of sex workers). To halt this infection, all HIV/AIDS linked services have been integrated and scaled up to sub-district and community level; though services available in any area are based on the prevalence there.

In high prevalence **districts**, the full spectrum of preventive, supportive and curative services are provided in medical colleges or district hospitals. **Community health centers** and **primary health centers** are integrated in the program and facilitate prevention through promotion of condoms, counseling and testing for HIV (ICT Centers), prevention of parent to child transmission (PPTCT), treatment and cure for sexually transmitted diseases and management of opportunistic infections. Hospitals providing HIV services are linked to **NGOs/CBOs**, that provides peer support services, home-based care for people living with HIV/AIDS, follow-up of children born to HIV positive women

and support at the community and outreach to services at the district level.

MANAGEMENT OF STI/RTI

Sexually transmitted diseases are one of the determinants of HIV transmission. Medical care for these diseases are very low, limited diagnostic facilities to manage complicated STDs and drug resistance to major STDs are the important issues of concern that NACP-III addresses.

Regional centers are planned to be set up during the program period to monitor drug resistance in syndromic oral/anal STDs, and develop guidelines for their treatment.

CONDOM PROMOTION

NACO advocates and promotes condom use as a safe sex practice for prevention of STI/RTI and HIV, in addition to protection from unwanted pregnancy. Although the availability of free supply, subsidised and commercial brands of condoms have been increased, but that did not have a significant impact. Now apart from stepping up condom advocacy, NACO has launched new management and distribution initiatives.

Under NACP-III condom promotion continues to be an important prevention strategy. The program seeks to increase condom use as well as access during sex with nonregular partner, increase the number of condoms distributed by social marketing programs, increase the number of free condoms distributed through STI and STD clinics, increase the number of commercial condoms sold and increase the number of nontraditional outlets for socially marketed condoms, e.g. paan shops, lodges, etc. in strategically located hotspots of solicitation.

NACO has launched a number of **innovative approaches** in promotion of condom use. Among them are: (i) Condom Vending Machines (CVM): That will provide anytime access to quality condoms in a non-embarrassing situation. (ii) Female Condoms (FC), (iii) Thicker, more lubricated condoms: A thicker, more lubricated condom branded “Spice Up” will be launched to cater to special needs of the high risk groups. These condoms will be socially marketed in the targeted intervention sites.

The program objective is to increase consistent condom use among men who have sex with nonregular partners and high risk groups to near 100 percent. Under NACP-III, NACO seeks to strengthen condoms availability by integrating social marketing with targeted interventions (TI) in rural and remote areas. All channels of communication will be used to promote condoms. While normalisation of condom use is accorded prime importance, barriers to condom use will be addressed. Irrational beliefs will be identified and addressed.

BLOOD SAFETY

The specific objective of the blood safety program is to ensure reduction in the transfusion associated with HIV transmission to 0.5 percent, while making available safe and quality blood within one hour of requirement in a health facility.

The activities and functioning of a large network of blood banks and blood component separation facilities in the country are supervised at district, state and national level.

NACO is committed to bridge the gap in the availability and improve quality of blood under NACP-III with the different strategies like, to raise voluntary blood donation to 90 percent, to establish blood storage centers in Community Health Centers and community care centers, to expand external quality assessment services for blood screening, quality management in blood transfusion services, sensitise clinicians on optimum use of blood, blood components and products etc. Red Cross Society, Nehru Yuva Kendra and National Service Scheme – all these voluntary blood donation camps in the districts are coordinated by district nodal officers (DNOs) in charge of AIDS control program.

RESOURCE GROUP

(TRG) on Blood Safety. Based on the laid down indicators, states are rated as poor performing, average performing and better performing. The poor performing states are visited by the consultant (Blood Safety) once in a quarter; other states are visited randomly for supervision. NBTC and TRG on Blood Safety provide feedback to NACO on the overview of blood transfusion services twice a year.

Integrated Counseling and Testing Center (ICTC)

Under NACP-III, Voluntary Counseling and Testing Centers (VCTC) and facilities providing Prevention of Parent to Child Transmission of HIV/AIDS (PPTCT) services are remodelled as a hub or Integrated Counseling and Testing Center (ICTC) to provide services to all clients under one roof. An ICTC is a place where a person is counseled and tested for HIV, of his own free will or as advised by a medical provider. The main functions of an ICTC are:

- Conducting HIV diagnostic tests.
- Providing basic information on the modes of HIV transmission, and promoting behavioral change to reduce vulnerability.
- Link people with other HIV prevention, care and treatment services.

An ICTC is located in the Obstetrics and Gynecology Department of a medical college or a district hospital or in a maternity home where the majority of clients

who access counseling and testing services are pregnant women. The justification for such a center is the need for providing medical care to prevent HIV transmission from infected pregnant women to their infants. Similarly an ICTC is located in a TB microscopy center or in a TB sanatorium, where the majority of clients are TB patients. As TB is the most common coinfection in people with HIV, availability of HIV counseling and testing can help patients to diagnose their status for accessing early treatment.

However, it is not the mandate of an ICTC to counsel and test everyone in the general population. The sub-populations that are more vulnerable or practice high risk behavior or have higher HIV prevalence levels are the target group for counseling and testing services in the country. Under NACP-III, the target is to counsel and test 22 million clients annually by the year 2012. People who are found HIV negative are supported with information and counseling to reduce risks and remain HIV negative. People who are found HIV positive are provided psychosocial support and linked to treatment and care.

Postexposure Prophylaxis (PEP)

INDICATIONS

- Needle stick injuries
- Cuts from other sharps
- Contact of eye, nose, mouth or skin with blood

OBJECTIVE

To prevent HIV infection of cells.

PROMPT MEASURES

Not to do panic, not to put finger into mouth. Affected part is washed with soap and water. Antiretroviral drugs should be started as early as possible within 2 hours and it is not recommended beyond 72 hours.

Regimen

- Zidovudine (300 mg BD) + Lamivudine (150 mg BD)
- If source individual has advanced AIDS, then nelfinavir is added.
- If source has failed on Zidovudine + lamivudine therapy, then Stavudine and Didanosine combination is used.

Duration

Therapy is continued for 4 weeks. If HIV antibody test is found to be positive at any time within 12 weeks, then treatment of HIV infection is started. If blood test is found to be negative, then the blood examination is repeated after 3 to 6 months.

PREVENTION OF PARENT TO CHILD TRANSMISSION (PPTCT)

The program aims to prevent the perinatal transmission of HIV from an HIV infected pregnant mother to her newborn baby. Counseling and testing of pregnant women is done in the ICTCs. Pregnant women found to be HIV positive are given a single dose of **Nevirapine** at the time of labor; and their newborn babies also get a single dose of Nevirapine immediately after birth so as to prevent transmission of HIV from mother to child.

CARE AND SUPPORT

As immunity level falls down over time in HIV infected people, the person becomes susceptible to various opportunistic infections (OIs). At this stage, medical treatment and psychosocial support is necessary. Since prompt diagnosis and treatment of OIs will ensure the better quality of life of PLHA's. NACP-III seeks high levels of drug adherence (>95%) and compliance of the prescribed ART regimen. This care, support and treatment approach will also create awareness about the prevention of HIV infection.

CARE AND SUPPORT FOR CHILDREN

NACP-III plans to improve this through early diagnosis and treatment of HIV exposed children by comprehensive guidelines on paediatric HIV care.

PEDIATRIC CARE AND SUPPORT

The primary goal of pediatric prevention, care and treatment program is to prevent HIV infection to newborns through Prevention of Parent to Child Transmission (PPTCT) and provide treatment and care to all children infected by HIV.

MONITORING AND EVALUATION AND RESEARCH

Other than sentinel surveillance, nationwide Computerised Management Information System (CMIS) provides strategic information on program monitoring and evaluation.

Monitoring

Strategic Information Management System (SIMS) at national and state levels will detect the emerging hot spots of the epidemic and would be helpful to provide two critical management functions namely (i) tracking the epidemic and (ii) tracking the performance of the program.

Evaluation

Each of the proposed intervention will be evaluated separately.

Research

NACO will conduct research on HIV/AIDS, not only in India, but in the entire South Asia region.

Surveillance

Information is gathered through HIV sentinel surveillance, behavioral sentinel surveillance and Sexually Transmitted Infections (STI) surveillance helps in tracking the epidemic and provides the direction to the program. Under NACP-III, PPTCT surveillance and ANC surveillance system are planned to be included in the program.

Behavioural Surveillance Surveys (BSS) throw light on the knowledge, awareness and behaviours related to HIV/AIDS among general population, youth as well as among different high risk group communities. It also throws light on the impact of the intervention efforts being undertaken through NACP.

Syndromic Approach to STD

As seen above, control of STD is one of the components of National AIDS Control Program.

Reproductive Tract Infections (RTIs) mean any infection of reproductive tract of male or female and sexually transmitted infections (STIs) are those that are passed from one person to another through sexual contact.

Sexually transmitted diseases (STDs) are major public health problem the world over and India is no exception. It is virtually impossible to assess the magnitude of the problem in India due to lack of reliable data and gross under-reporting. It is estimated that more than 40 million cases are reported as new cases every year and as many as 1 or 2 women in every ten are infected with an STD. It is probably the most prevalent communicable disease in India (**Table 18.17**).

STDs produce considerable wastage of manpower besides untold misery, both directly and indirectly through the complications they produce (**Table 18.18**). The new entrant in the spectrum of STDs, named as Acquired Immunodeficiency Syndrome (AIDS) has increased the importance of prevention and control of STDs.

A major handicap in prompt and proper treatment of STDs has been the nonavailability and non-accessibility of venereologists and STD clinics to patients.

Factor contributing spread of reproductive tract/sexually transmitted infections

- Human behavior
- Lack of awareness about STIs
- Lack of access to healthcare
- Healthcare providers not adequately trained
- Poor medical services
- Migrating population
- Hygiene and environmental factors

TABLE 18.17: Common reproductive tract/sexually transmitted infections

Both male and female	Only in females
Gonorrhoea, Chlamydia, Syphilis, Genital herpes, Lymphogranuloma venereum, Chancroid, HIV, HBV, Trichomonas, Genital warts, Candidiasis, Scabies, Pubic lice, Molluscum contagiosum	PID, Bacterial vaginosis
	Only in males
	Epididymitis/Orchitis

TABLE 18.18: Complications of reproductive tract/sexually transmitted infections

Men	Women
Urethral stricture, Phimosis/paraphimosis, Infertility, Disfigurement of genitals, Cardiovascular complications (syphilis), Neurosyphilis	Pelvic Inflammatory Disease (PID), Infertility, Chronic pelvic pain, Spontaneous abortion, Ectopic pregnancy, Low birth weight baby, Stillbirth, Increased susceptibility to opportunistic infection, Cervical cancer
Neonates	Systemic infections
Congenital eye infections – Syphilis, chlamydia, gonorrhoea, Sepsis, Meningitis, Mental retardation, Arthritis	Proctitis, proctocolitis, Acute membranous granulonephritis, Myocarditis, aortitis, Iritis, coroidoretinitis, Septicemia, Tabes dorsalis, Osteomyelitis, arthritis

The traditional approach to diagnosis of a presumed sexually transmitted infection is through etiological diagnosis established by microscope and laboratory culture. This approach is expensive and slow in obtaining results. Clinical diagnosis without any test would be a cheaper approach but is inaccurate or incomplete in the majority of instances. The limitations of these approaches have led to the development and advocacy of a third strategy which is the syndromic approach.

The government has decided to propagate the syndromic approach so that PHC and dispensary medical officers and general medical practitioners may be able to manage STD patients effectively and scientifically.

The syndromic approach, when operating most effectively, performs better than a laboratory test-based approach. It has a number of advantages over other approaches including avoidance of the need to wait for the result thereby increasing compliance and overall cure rates. Cost-effectiveness is increased through money being saved on laboratory tests. This approach is feasible for both urban and rural areas and can be integrated into other services (MCH/PHC/FPCs). There is good evidence that syndromic case management can produce impressively high (95 percent) cure rates after one visit for most STD patients. Early treatment can cure transmission of HIV significantly.

ETIOLOGICAL DIAGNOSIS APPROACH

Etiological diagnosis poses several problems. Identification of as many as 20 STD causative organisms requires skilled personnel and sophisticated laboratory. For example, gonococcal and chlamydial infections require facilities like culture, which are nonexistent in many a laboratory set-up. Primary and secondary syphilis needs dark-field microscopy. Tests for other STD like herpes, etc. are even more complicated.

CLINICAL DIAGNOSIS APPROACH

Majority of patients with STD seek treatment from general practitioner's clinic or ill equipped STD clinics which lack required facilities and skilled personnel. Laboratory services are both expensive and time consuming. Similarly, clinical diagnosis has limitations. It is difficult to differentiate between various types of infections especially in the presence of mixed infections. For example, clinical distinction cannot always be made between gonococcal infection and chlamydial urethritis. Studies have shown that clinical diagnosis is reliable only in 5 percent cases of STD.

SYNDROMIC APPROACH

In syndromic approach the symptoms and signs are grouped to identify the syndrome. This approach is based upon:

- Classifying the main etiological agents by clinical syndrome, and
- Using the flow charts.

ADVANTAGES OF SYNDROMIC CASE MANAGEMENT

- Scientific
- Simple to treat with good drug compliance
- Free from errors in clinical judgement
- Effective against mixed infections
- Cost effective in the long run and does not require laboratory tests
- Control spread of STD by offering immediate treatment at first visit.
- No need for patient to return for lab results.
- Easy for health workers to learn and practice for patients.
- Integrated into primary health care services more easily and can be used by providers at all levels.
- Syndromic management goes beyond pharmaceutical treatment to include client education and counseling.

LIMITATIONS OF SYNDROMIC CASE MANAGEMENT

- Not useful in asymptomatic individuals.
- Over treatment in patient with single STI that causes a syndrome.
- Financial cost of over treatment and side effects.
- Not effective in some cases such as vaginal discharge.
- Increases potential for antibiotic resistance especially if full course not completed.

STD SYNDROMES

Even though STD are caused by different organisms, these organisms give rise to only a limited number of syndromes. A syndrome is simply a group of symptoms complained of by patients and the signs found on examination.²⁶ There are six major syndromes (**Flow charts 18.1 to 18.7**).

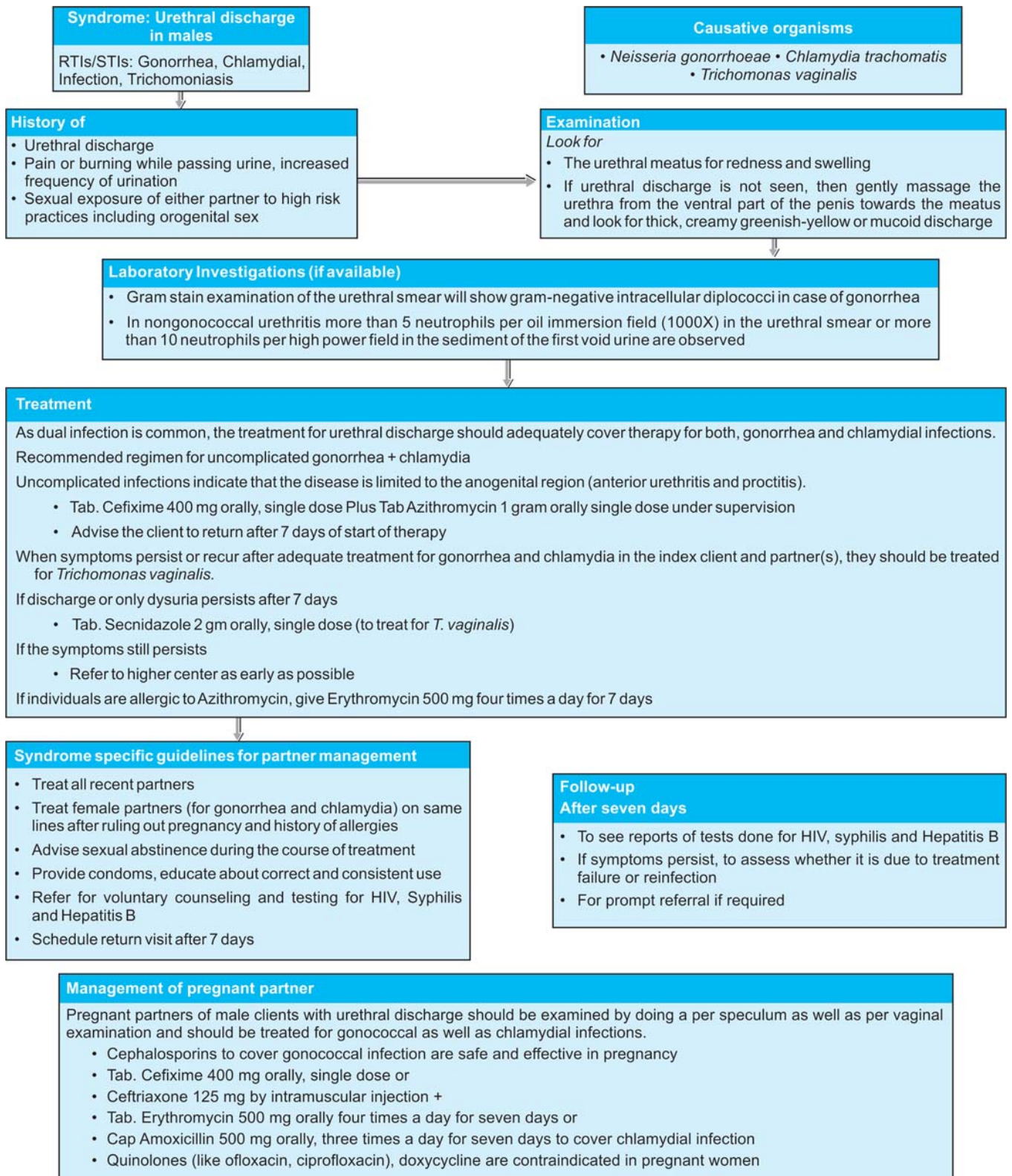
1. Genital ulcer
2. Urethral discharge in males
3. Vaginal discharge
4. Inguinal swelling
5. Lower abdominal pain in females
6. Scrotal swelling.

COMPONENTS OF SYNDROMIC CASE MANAGEMENT

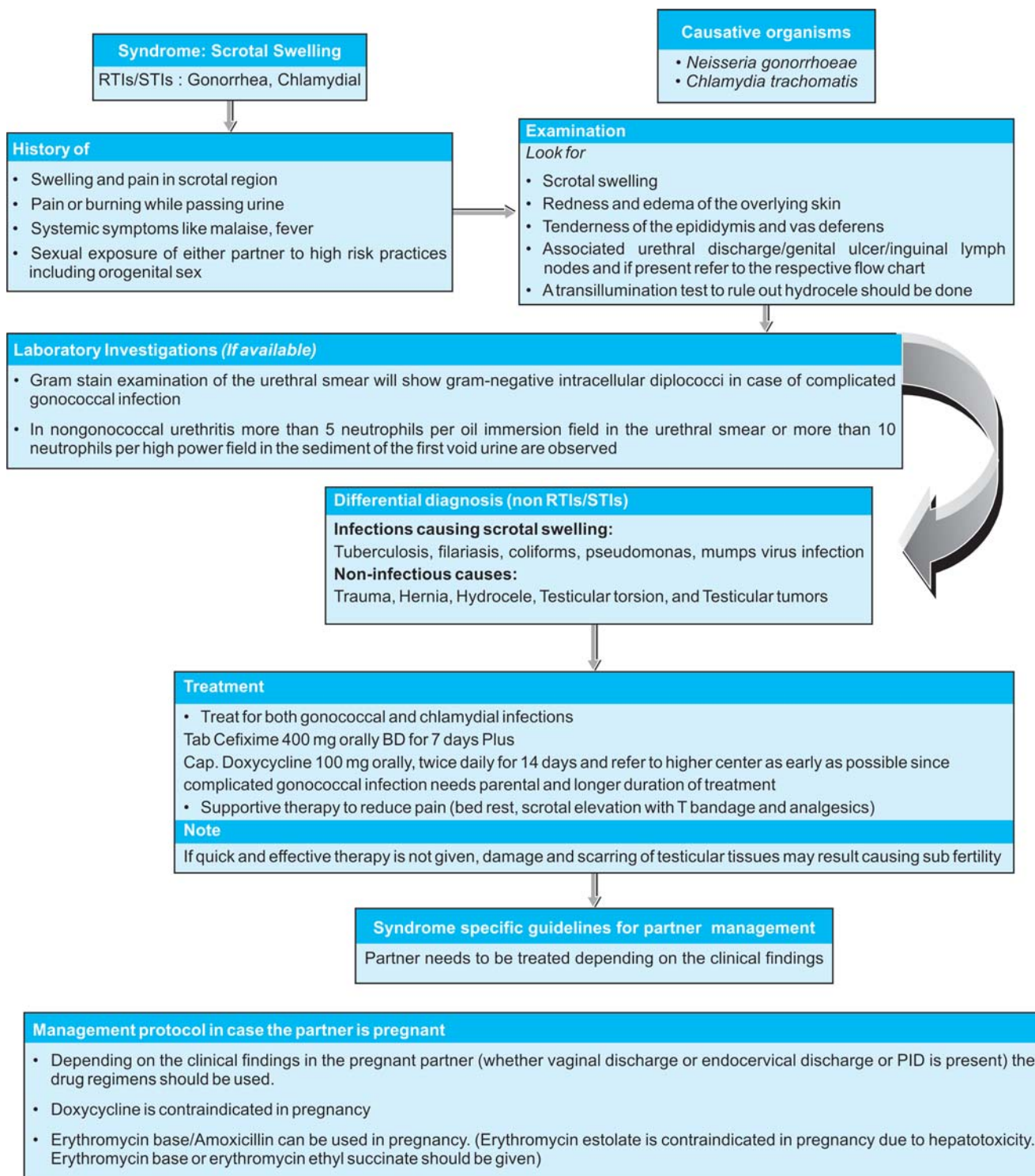
- History taking including sexual history
- Clinical examination
- Syndromic diagnosis
- Syndromic treatment
- Counseling and education
- Promotion and provision of condoms
- Partner management
- Referral for ICTC and VDRL test
- Follow-up.

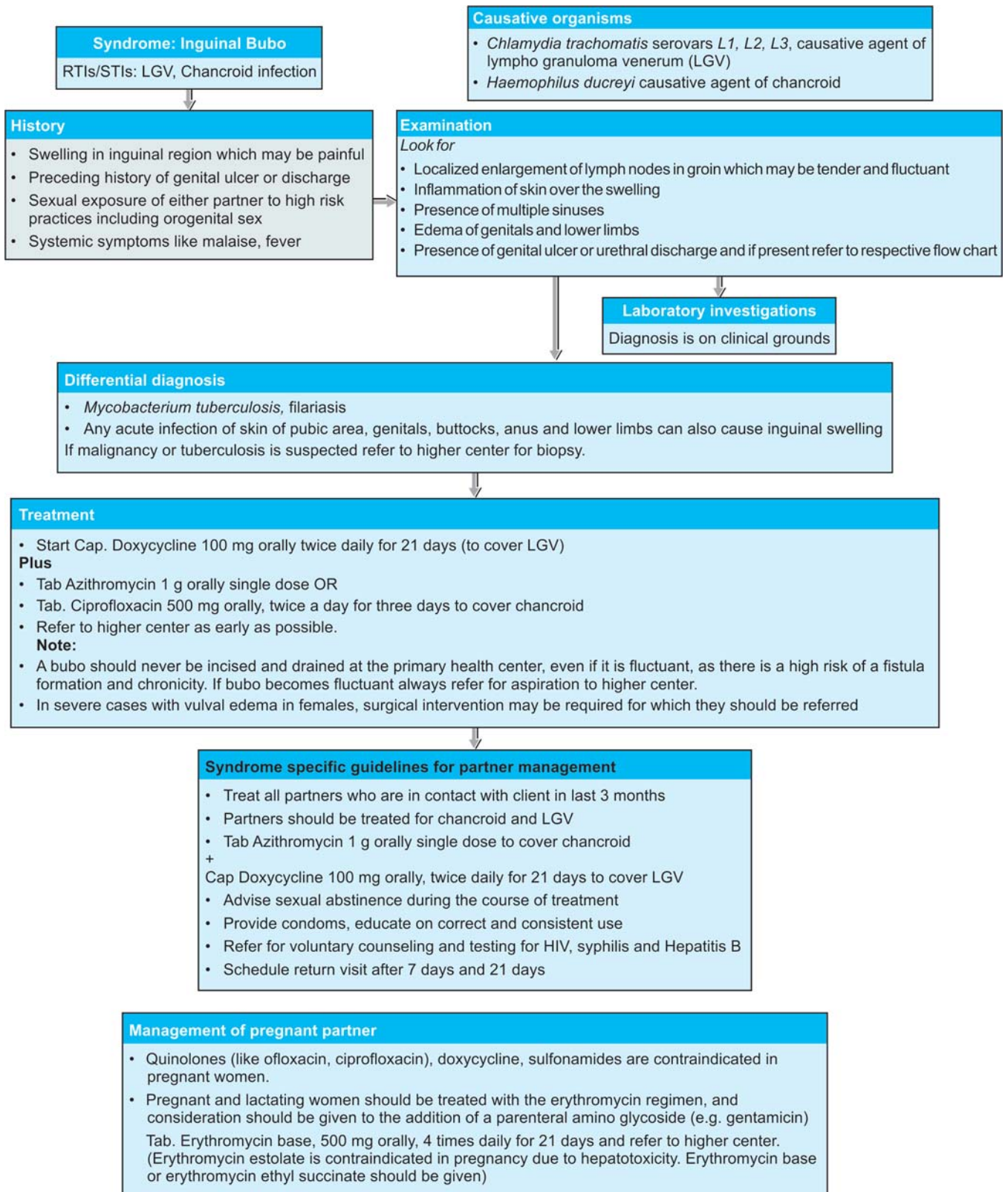
PATIENT EDUCATION

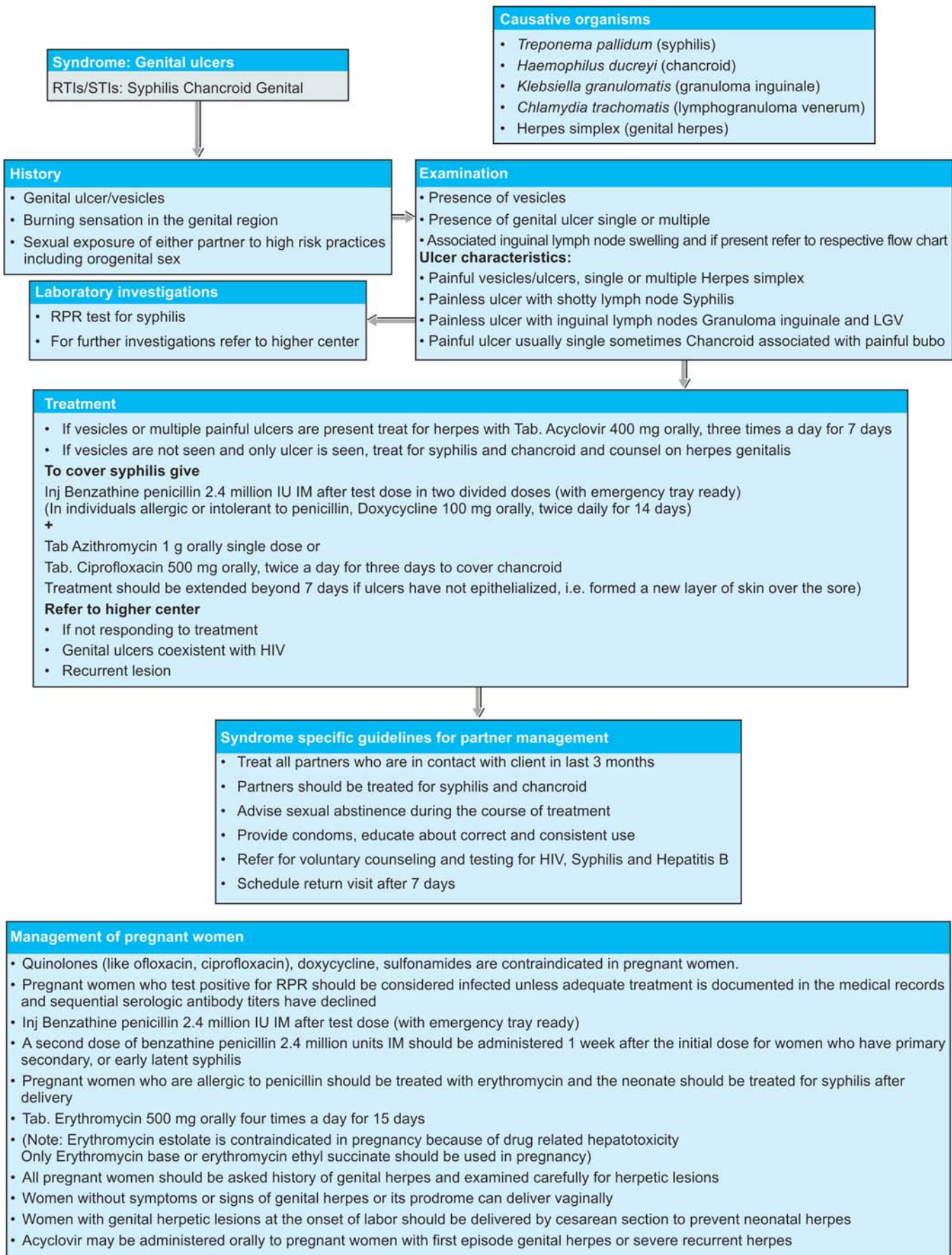
- Taking the full course of treatment will cure most STIs.
- Avoid sex during treatment period to prevent spread of STIs
- Help sexual partners to get treatment
- Condom use to stay uninfected
- Reduce risk of acquiring new infection by having one sex partner
- Protect against HIV/AIDS
- In case of pregnancy, report to antenatal clinic to protect both mother and baby.

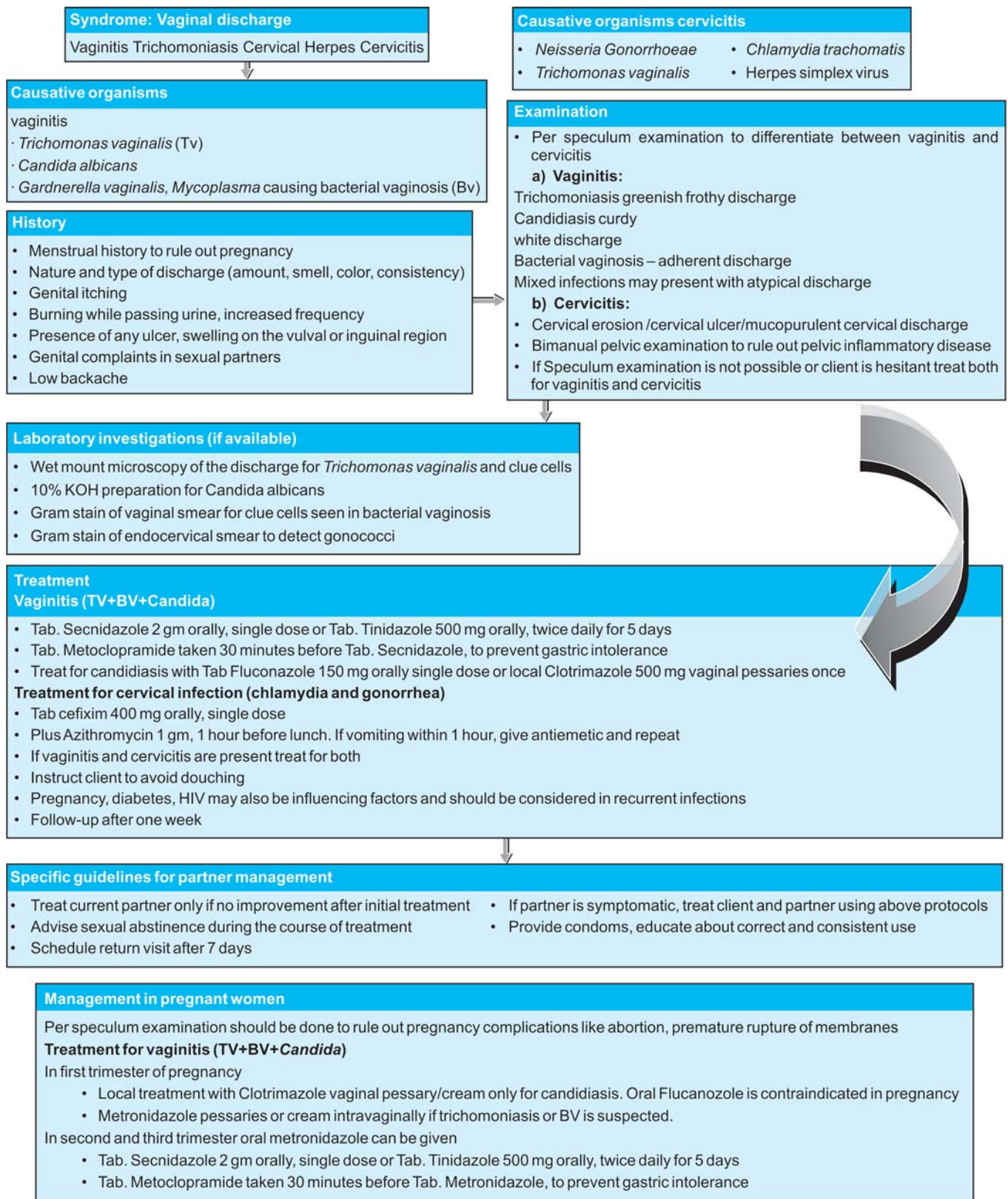
Flow chart 18.1: Management of urethral discharge/burning micturition in males²⁶

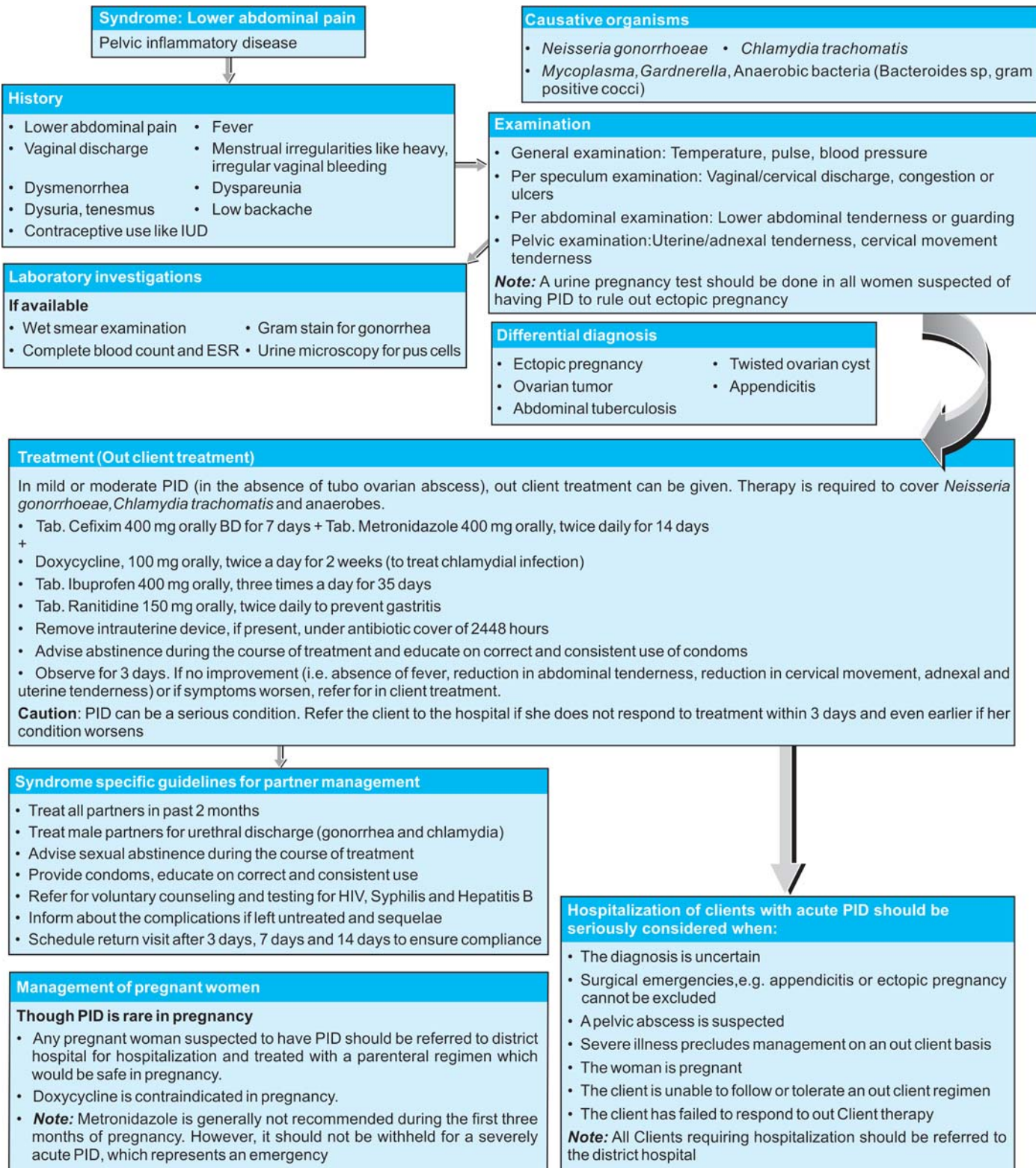
Flow chart 18.2: Management of scrotal swelling²⁶

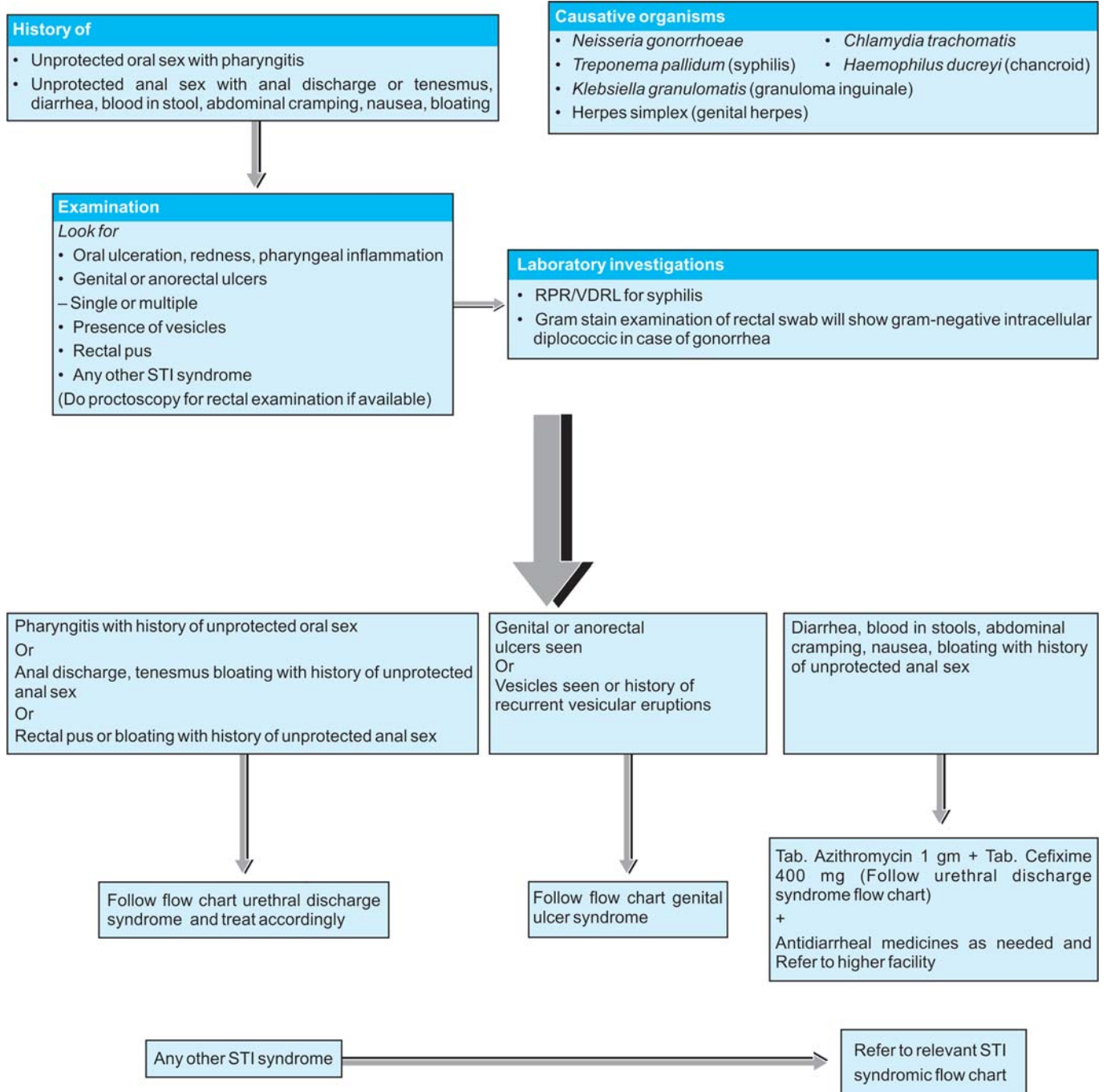


Flow chart 18.3: Management of inguinal Bubo²⁶



Flow chart 18.5: Management of vaginal discharge in females²⁶



Flow chart 18.7: Management of oral and Anal STIs²⁶

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Trachoma (ICD-A71.9)

Identification

Trachoma is a form of follicular or granular conjunctivitis characterized by pain, redness and inflammation of conjunctiva, particularly upper palpebral conjunctiva, along with lachrymation. Pus discharge is due to invasion of secondary microlimbus (pannus). Cicatrization entropion, ectropion, trichiasis and corneal ulcers are common complications. Ulcers lead to opacities and blindness. Both acute and chronic forms occur. Halbestor Prowazek bodies are characteristics of trachoma.

Occurrence

Trachoma was earlier estimated to infect 120 million persons, accounting for 5 percent of visual impairment and blindness in India.¹ Its prevalence has declined markedly during recent years. It varies in different parts. In general, it decreases as one proceeds from north to south and from west to east. This is thought to be related to less dust and sand in the environment in southern and eastern parts of India.

CAUSATIVE AGENT

Trachoma is caused by an organism *Chlamydia trachomatis*, which closely resembles bacteria but reproduces only within living animal cells. *Ch. trachomatis* immunotypes C and A, and sometimes B, cause trachoma; type B and D to K cause inclusion conjunctivitis and types L-1, L-2 and L-3 cause lymphogranuloma venereum. All these are collectively referred to as TRIC agents and may be responsible for conjunctivitis. Their differences are given in **Table 18.19**.

SOURCE OF INFECTION

Man, mostly children below 10 with discharging eyes.

Transmission

It is usually through direct contact with the ocular discharge and, possibly, mucoid or purulent nasal discharges of the infected persons as also through contact with materials soiled with such discharge (fingers, handkerchief, eye dropper, kajal or surma stick, etc.). Flies may also act as carriers of infection from infected to healthy eyes.

SUSCEPTIBILITY AND RESISTANCE

Children below 10 years are more prone to be infected. Exposure to smoke, dust, sunshine and dry winds, low

TABLE 18.19: Conjunctivitis caused by TRIC agents

Distinguishing features	Trachoma	Inclusion conjunctivitis	Ocular LGV
Follicles	Yes	Yes	No
Conjunctival scars	Yes	No	Yes
Corneal scars	Yes	No	Yes
Gross pannus	Yes	No	Yes
Micropannus	Yes	Yes	Yes
Blindness	Yes	No	Rare
Genital source of infection	More data needed	Usual	Always
Eye-to-eye spread	Usual	Rare	No data
Conjunctival scrapings: Inclusion bodies in			
• epithelial cells	Yes	Yes	No
• monocytes	Yes	No	

standard of personal hygiene, malnutrition and overcrowding favor susceptibility. Infection does not confer immunity and no vaccines are available.

INCUBATION PERIOD

5 to 12 days as determined from experience on human volunteers.

PREVENTION AND CONTROL

Health Education

People should be told about the mode of spread and asked to avoid use of common towels, fingers, handkerchiefs and other articles for cleaning or wiping the eyes. They should take early specific treatment. Dust and smoke should be controlled. Dark glasses should be used while moving in the sun.

Early Diagnosis

Cases should be detected by mass surveys and given treatment. In a difficult case, diagnosis is confirmed by demonstration of intracytoplasmic inclusion bodies in conjunctival scrapings stained by Geimsa or immunofluorescent stain. However, mass surveys for detection and treatment pose complex organisational problems. It is hence recommended^{2,3} that if 5 percent or more children below 10 years in a community have moderate or severe trachoma, a blanket or mass treatment should be instituted.

Treatment

SAFE strategy has been adopted (S: Surgery, A: Antibiotic, F: Facial cleanliness, E: Environmental sanitation). Tetracycline ointment is the sheet-anchor of treatment. It is highly effective when applied in the eyes thrice daily for at least five weeks. Erythromycin and rifampicin eye ointments are also effective. Systemic tetracycline, erythromycin or sulfamethoxazole (30 mg/kg per day) for 3 weeks are as efficient as topical

ointment. Sulfacetamide eye drops are no longer the treatment of choice for trachoma. When individuals have lid deformities such as entropion, necessary surgical correction needs to be done to prevent blindness. Surveillance of the community which has been given mass treatment should be continued for several years after the active disease has been controlled.

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Fungus Infections

There are two types of fungus infections or phytozes. Dermatophytes affect the skin. Common examples are ringworm and favus. Systemic mycoses affect the internal organs where infective granulomata are formed. Examples are actinomycosis (Ray fungus infection), maduramycosis (Madura foot), moniliasis or candidiasis (thrush) and histoplasmosis.

Ringworm (*Tinea*) (ICD-B35.9)

CLINICAL FEATURES

It is a low grade infection that grows in the horny layers of skin, in hair and in nails where it induces an inflammatory reaction. The lesion is seen in patches which have a healing scaly center and a ring like spreading edge. They are not produced by mere implantation of the fungus on the skin; allergy and sensitization of skin are prerequisites. The lesions are given various names as per the site involved as described below:

- *Tinea pedis* (*Athlete's foot*): It affects the toes, especially 4th and 5th, and is transmitted through common bath, shoes and socks, especially when sweating is profuse.
- *Tinea cruris* (*Dhobie's itch*): It affects genitocrural skin and, sometimes, the under surface of breasts. It may

be transmitted through underwears, toilet seats and sexual contact.

- *Tinea corporis (Tinea circinata)*: It occurs as disk like patches on the face, neck, trunk, or limbs. It spreads through clothes and bath.
- *Tinea barbae*: It affects the face and is transmitted through the instruments of a barber.
- *Tinea capitis*: It occurs on the scalp in children and adolescents. Barber's tools and backs of cinema seats may be involved in transmission.
- *Tinea unguium*: Ringworm of nails; it may be due to autoinfection or contact with an infected person.

CAUSATIVE AGENT

Ringworm is caused by three types of fungi, Microsporon, Trichophyton, and Epidermophyton. It is prevalent all over the world, more so in the tropics and subtropics. Favus is ringworm of scalp caused by a type of trichophyton fungus called achorion. Source of infection is the patient having the disease; sometimes domestic pets such as cats, dogs and cattle may also act as source of infection. Transmission is by direct or indirect contact.

INCUBATION PERIOD

10 to 14 days.

PREVENTION AND CONTROL

- Foot-bath in hypochlorite solution and a general bath with soap and water should be taken before entering a swimming pool. Toes should be kept clean and dry. Socks and shoes of infected persons should not be used.
- Barbers should be licensed. It should be ensured that the instruments they use are clean.
- Clothes of an infected persons should not be worn.
- Skin or sex contact with an infected person should be avoided.
- Contact with infected cat or dog should be avoided.
- Prompt and thorough treatment of all cases and contacts should be carried out with 5 percent salicylic or 5 percent benzoic acid or both. Newer antimycotic agents, e.g. miconazole, are much more effective. Griseofulvine, an oral drug, is used for infections of skin, hair and nails. It is administered in the form of 0.25 g tablets 4 times a day or as a single 1 g dose per day till 2 weeks after cure.

Yaws (ICD-A66.9)

Yaws, also known as frambesia has been prevalent in tropical and subtropical regions such as East and West

Africa, Malaya, Philippines. Fiji, India, Burma, Ceylon, Brazil and West India. In India it is found in hill tribes of Madhya Pradesh and also in parts of Orissa, Andhra Pradesh, Gujarat and Maharashtra. The affected districts include West Godavari, Khammam and Vijayanagaram in Andhra Pradesh, Bastar in Madhya Pradesh and Keonjarh, Mayurbhanj, Dhenkanal, Balasore and Koraput in Orissa.¹ As a result of persistent campaign against yaws carried out with WHO and UNICEF support, the world prevalence of yaws cases in the world was estimated to be 1 to 2 million in 1976 compared to 50 to 100 million in 1950.² An intensive antiyaws campaign brought down the prevalence of active yaws in Fiji from 28.1 percent in 1957 to 0.008 percent in 1966. In India, 535 laboratory confirmed cases and 7639 suspected cases of yaws were reported in 1997.³

CLINICAL FEATURES

These are described in 3 stages.

1. *Primary or early stage*: Primary sore, called 'mother yaws', appears as a large papule, about 6 cm in diameter, or as a vesicle on the knee or near the mouth. It scabs, becomes nodular and develops into a papilloma. Infective serous fluid exudes from the lesions.
2. *Secondary stage*: After 6 to 8 weeks, there is a typical rash when papules resemble a raspberry, hence the name 'frambesia'. The rash consists of large, yellow crusted and granulomatous lesions occurring on any part of the body. They fall off without pain. Periosteum and bone may be involved.
3. *Tertiary or late stage*: It occurs after about five years, may be in adult age, and is characterized by gummatous lesions near bones and joints. Goundou, a swelling by the side of the nasal bridge and gangosa, ulcerative lesions on palate, are special forms of this stage.

The disease lasts for about a year and is usually non-fatal.

AGENT

It is caused by a spirochaete called *Treponema pertenue*. The organism is found in the lesions, lymph glands, spleen and bone marrow. *T. pertenue* measures 20 microns in length and has 8 to 12 rigid spirals. Man is the only reservoir.

HOST FACTORS

Yaws primarily affects children and adolescents though cases can be found at any age. There is a male preponderance. No natural immunity is known.

ENVIRONMENTAL FACTORS

Yaws is found in warm and humid regions. Areas with high rainfall are very prone to yaws.

TRANSMISSION

Mode of transmission can be by direct contact with secretions of infectious lesions, by fomites or by certain vectors like flies and insects which spread the disease by mechanical contact.

INCUBATION PERIOD

3 to 5 weeks.

METHODS OF CONTROL

These include mass surveys, case finding and specific treatment and continuous surveillance. Health education about personal cleanliness and the mode of spread is necessary. Measures to improve environmental sanitation are also important.

Treatment

A single injection of benzathine penicillin G 1.2 million units is usually enough. The dose for children below 10 years of age is 0.6 million units.

In areas where yaws is hyperendemic, (more than 10% of clinically active yaws), mass treatment with penicillin in the above dose is recommended for the entire population. If the area is in a mesoendemic zone (5 to 10% prevalence), treatment is given to all cases and to all children under 15 years of age. In

hypoendemic areas (less than 5% prevalence), treatment is confined to infected cases and their contacts.⁴

YAWS ERADICATION PROGRAM (YEP)

Yaws is amenable to eradication. This is possible through interruption of transmission. The YEP has been initiated with this objective.³ It was started in 1996 to 97 in Koraput district, Orissa, as a central sector health scheme. In 1997-98, it was extended to MP, AP, Maharashtra and Gujarat. The National Institute of Communicable Diseases, New Delhi, is the nodal agency for the program. The program strategies include:

- Manpower development
- Case detection
- Simultaneous treatment of cases and contacts
- IEC.

The program is implemented by the state authorities utilizing the primary health care infrastructure.

Scabies

It occurs all over the world in the poor strata of society, living in unhygienic conditions. It has already been discussed in detail in Chapter 11.

References

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Arthropods are responsible for transmitting a large number of diseases as already described in Chapter 11. These diseases will now be described in the following sequence: mosquito-borne diseases, (malaria, filariasis, yellow fever, dengue, chikungunya fever, Japanese encephalitis) fly-borne disease (sandfly fever, leishmaniasis), flea-borne diseases (plague), tick-borne diseases (KFD) and diseases transmitted by more than one type of arthropod, such as certain rickettsial infections (epidemic typhus, trench fever, endemic typhus, scrub typhus, rocky mountain spotted fever) and relapsing fever.

Malaria (ICD-B54)

Identification

The symptoms and signs of malaria depend upon the type of plasmodium, the infecting protozoal parasite in blood that causes the disease.

- *Benign tertian malaria*: It is caused by *P. vivax*. In some cases, continuous fever may occur for a few days before typical bouts of fever on every third day set in. There are three stages in a typical attack:
 - In *cold stage*, the patient has marked shivering, lasting for about half an hour.
 - In *hot stage*, there is fever up to 39.5 to 40.5°C, lasting for 1 to 5 hours
 - In *sweating stage*, the temperature falls. The patient feels comfortable and falls asleep.
- *Malignant tertian malaria*: It is caused by *P. falciparum*. Onset is insidious, the fever being prolonged and irregular, but not very high. Sometimes the patient may be afebrile, even with heavy infection. The three typical stages described above are rare. Vomiting and headache are common. Falciparum malaria is known to mimic many febrile conditions. It is characterized by heavy invasion of RBCs so that, in severe cases, every 10th cell may be parasitized.

Serious complications due to interference with capillary circulation, destruction of RBCs and toxemia may occur in falciparum infection. The following presentations of falciparum malaria may be fatal:

- *Cerebral malaria*: There may be sudden coma, mental changes, aphasia and hemiplegia or monoplegia.

- *Intestinal malaria*: There is vomiting or diarrhea, with or without blood.
- *Blackwater fever*: There is intravascular hemolysis. Urine contains blood. Its color varies from dark red to black, hence the name.
- *Renal malaria*: Glomerulonephritis and nephrotic syndrome have also been described.
- *Quartan malaria*: It is caused by *P. malariae* and presents with mild symptoms. The bouts come in three stages as in the benign tertian malaria, but occur every 4th day.
- *P. ovale malaria*: It is caused by a relatively rare malarial parasite found in Africa. The symptoms are similar to *P. vivax* infection.

RELAPSES

Plasmodium vivax and *ovale* may persist in man for a long time in the liver in the form of dormant forms called hypnozoites. These exoerythrocytic forms may be responsible for recrudescence of infection after a lapse of months or even years following mosquito bite or after incomplete treatment of malaria (**Table 19.1**). The exoerythrocytic forms do not persist for long in case of *P. malariae* and *P. falciparum* infections. In case of *P. vivax* and *P. ovale*, the relapses keep on occurring without fresh infection from outside. Hypnozoites left behind in the liver reach blood and start new cycles of infection. Eventually, immunity is established in 1 to 2 years and relapses cease.

RECRUDESCENCE

The phenomenon of reappearance of clinical malaria or Malaria parasite in blood, due to reactivation of

TABLE 19.1: Characteristics of disease caused by two major species of malaria parasites

Characteristic	<i>P. falciparum</i>	<i>P. vivax</i>
Exoerythrocytic cycle	6-7 days	6-8 days
Incubation period	9-14 days (12)	12-17 days (15)
Severity of primary attack	Severe	Mild to severe
Duration of untreated infection	1-2 years	1.5-5 years
Relapse	No	Yes
CNS and other complication	Frequent	Infrequent
Anemia	Frequent	Common

parasites, which remain dormant in the RBC itself. The parasite some times remain in silent stage due to increase host resistance which may reactivate when immunity decline.

CHRONIC MALARIA

It is common in endemic zones where reinfection continues. Anemia, ill health, cachexia, enlarged spleen, slight icterus, butterfly pigmentation of the face, variable degree of fever and parasitemia are the common features. Repeated episodes produce a variety of immune response as well as parasitic tolerance. Large amounts of IgG and IgM are produced together with an enlargement of the spleen. These are the features of the Tropical Splenomegaly syndrome.

Infants and the young are very susceptible and may die of fever and gastrointestinal or pulmonary complication. Growth and development are retarded. By adult age, relative immunity has developed. The enlarged malarial spleen is very friable and may rupture due to a light thrust on the abdomen. Abortion may occur because of infection of the placenta. Malaria in pregnancy is associated with LBW delivery and increase risk of deaths of mother and baby.

Laboratory Diagnosis

All fever cases should preferably be investigated for malaria by Microscopy or Rapid Diagnostic Test (RDT). The results of parasitological diagnosis should be available within a short time (less than 2 hours) of the patient presenting. If this is not possible, the patient must be treated on the basis of a clinical diagnosis.

Blood Smear Examination/Microscopy

Both thick and thin films are made and examined for malarial parasite. Repeated microscopic examination may be necessary, especially when the patient has received partial treatment. This is particularly so in case of *P. falciparum*, in which case the parasites are often scanty in blood. Mixed infections are quite common. Indirect fluorescent antibody technique is of help in diagnosing malaria. The test is positive after a week of infection and may remain so for years. It is possible to distinguish the various species of malaria parasite and their different stages. It can be used to assess response to antimalarial treatment. The test requires relatively high degree training and supervision for reliable results. Under optimal conditions the sensitivity and specificity of the test is >90 and 100 percent respectively but under typical field conditions the sensitivity and specificity of the test is 25 to 100 percent and 56 to 100 percent respectively. The form of parasite detected in slide includes ring form (mostly), trophozoite, schizont and gametocyte.

Rapid diagnostic test (RDT): An antigen-based stick, cassette or card test for malaria in which a colored line indicates that plasmodial antigens have been detected. This simple test is used when laboratory facilities are not available. The results of the test are available instantly. RDTs for detection of parasite antigen are generally more expensive. The sensitivity and specificity of RDTs are variable under the influence of high temperatures and humidity. In India the test can be done by ASHA after receiving training.

While taking blood smears for diagnosis of malaria, there is no need to waste time by trying to synchronise blood smear with parasitemia. Such timing is irrelevant. What is important is the number of smears examined. Two or three smears collected every 8 to 12 hours are usually sufficient for diagnosing malaria. This is true of even the falciparum type, which is more difficult to detect.

INFECTIOUS AGENT

The malarial parasite was discovered in 1880 in human blood by Laveran. Manson (1894) postulated that malaria was transmitted by mosquitoes. Ronald Ross found oocysts in the stomach of mosquitoes fed on patient's blood in 1897. The whole cycle of the malarial parasite in man as well as in mosquito was thoroughly studied in the subsequent years.

The causative agent is a unicellular protozoan belonging to class sporozoa, order hemosporidium and genus plasmodium. *P. vivax*, *falciparum* and *malariae* are roughly responsible for 50 to 55 percent cases in India and are found in all regions. *P. malariae* is more common in tribal areas and accounts for 5 percent cases. *P. ovale* is not found in India. Mixed infections are found in 4 to 5 percent cases of malaria. *P. vivax* invades only the young RBCs, which constitute 1 to 2 percent of the total. Hence it is benign in nature. *P. falciparum*, on the other hand, can affect all red cells and hence produces a greater degree of hemolysis. The prevalence of falciparum malaria is increasing in most countries, including India.

Man is the intermediate host in whom the parasite undergoes asexual cycle called schizogony and early sexual cycle called gametogony. Mosquito is the definitive host in which sexual forms or gametes complete and sexual cycle called sporogony and produce sporozoites.

Vectors of malaria in India: Several species of Anopheles mosquitoes are found in India *Anopheles culicifacies* is the main vector of malaria. It is a zoophilic species. Most of the vectors, including *Anopheles culicifacies*, start biting soon after dusk and rests during daytime in human dwellings and cattle sheds (**Table 19.2**).

Cycle in Man

This occurs in four phases:

1. Sporozoites enter the human blood through the bite of a female mosquito. They disappear from blood

TABLE 19.2: Malaria vectors in India

Species	Area	Breeding place	Special features
• <i>A. culicifacies</i>	Peninsular and North West India	Irrigation channels, sluggish streams, rice-fields, rainwater	Chiefly bites between 22.00-00.30 hours. Associated with regional pools, tanks and swimming pools epidemics of great severity
• <i>A. fluviatilis</i>	Foothills of South India and UP, J and K, Rajasthan	Irrigation channels, shallow wells, rice-fields, tanks	Usually feeds before mid-night Major foothill vector of South India
• <i>A. minimus</i>	UP, foothills, Bengal, Assam	As above	Feeds mainly between mid-night and 02.00 hours
• <i>A. philippinensis</i>	Deltaic Bengal, Assam, UP	tanks, pools	Major foothill vector of UP, Bengal, Assam
• <i>A. stephensi</i>	Peninsular and North West India Important rural vector in North	Wells, fountains, cisterns, pools, sluggish streams	Commences to bite at dusk or soon after. Chief urban vector of India.
• <i>A. sondaicus</i>	Coasts of Orissa, North Tamil Nadu, Bengal, A and N island	Brackish water, lagoons and tanks. May breed in fresh water	West India Coastal vector. Brackish water breeder
• <i>A. annularis</i>	Orissa coastal plains, Jhansi (UP), Garo hills (Assam)	Stagnant water	Vector of local importance only
• <i>A. balabacensis</i>	East Assam, Burma	Forest pools and streams	
• <i>A. varuna</i>	Travancore and East peninsular India	Rainwater pools, tanks, wells irrigation channels	

Note: No. 1-6 are major vectors, of which Number 1 and 2 are most important. 70% malaria in India is caused by *A. culicifacies*.

within half an hour and reach the reticuloendothelial system, mostly liver, to undergo *preerythrocytic* phase. In the parenchymal cells of liver, the sporozoites pass through schizont stages, called cryptozoites, which develop into merozoites. Merozoites may further repeat proliferative cycles in the liver and thus multiply in number. This phase lasts for 8 days or more in *vivax* and for 6 days in *falciparum* infection.

- From liver, the merozoites escape into blood and undergo the *erythrocytic phase* or asexual cycle consisting of ring, ameboid or trophozoite, schizont and merozoite stages. Merozoites again enter fresh RBCs and complete the cycle every 2 or 3 days, depending on the species.
- After 7 to 10 days, some merozoites develop into sexual forms known as male and female gametocytes. This part of the cycle is called gametogony, *sexual phase* or *infective phase*.
- Exoerythrocytic phase*—All preerythrocytic forms come out of the liver in case of *P. falciparum*. In case of *P. vivax* however, they persist in the liver (tissue phase) and are responsible for relapses. These persistent forms are called hypozootes and are capable of developing into merozoites months or years later.

Cycle in Mosquito

The gametocytes are sucked in with blood when the female mosquito bites the patient or carrier. They change to male and female gametes and unite to form a zygote which develops in the stomach, wall of the

mosquito into ookinete, oocyst, sporocyst and sporozoite stages. This cycle takes 7 to 20 days and the period is sometimes referred to as the *extrinsic incubation period*.

PROBLEM STATEMENT

The 109 countries and territories classified as endemic for malaria, or previously endemic with the threat of reintroduction of infection in year 2008. About half the world's population (3.3 billion) live in areas that have some risk of malaria transmission. There were an estimated 247 million malaria cases (5th to 95th centiles, 189 to 327 million) worldwide in 2006, of which 91 percent or 230 million (175 to 300 million) were due to *P. falciparum*. The percentage of cases due to *P. falciparum* exceeded 75 percent in most African countries but only in a few countries outside Africa. The number of cases reported by national malaria control programs (NMCPs) was only 37 percent of the estimated global incidence. There were an estimated 881 000 deaths worldwide in 2006, of which 90 percent were in the African Region, and 4 percent in each of the South-East Asia and Eastern Mediterranean regions. World Malaria Day - 25th April—which was instituted by the World Health Assembly at its 60th session in May 2007 - is a day for recognizing the global effort to provide effective control of malaria.

BURDEN IN SEA REGION

Around 40 percent of the global population at risk of malaria resides in SEA Region and accounts for 8.5

percent of the global and around 4.1 percent (Fig. 19.1) of the global mortality due to malaria. WHO estimates that globally 33.96 million DALYs lost due to malaria in which SEA Region contributes around 1.34 million. The malaria situation in the region remains highly dynamic and evolving, and likely to be further aggravated by climate change. There is an evidence to show that warming of the earth's temperature and increasing precipitation will hasten maturation of the parasite in mosquitoes, increase the biting frequency and create conditions more conducive to mosquito breeding.

During 2000 to 2008, in SEA Region, malaria incidence remains between the range 2.19 to 2.83 millions. The countries showing significant reduction in malaria incidence are Bhutan, Korea (DPR), Sri Lanka and Thailand. About 95 percent of the population of moderate to high risk of malaria in SEA region is living in India, Indonesia, Myanmar and Thailand. More than 90 percent of the confirmed malaria cases and deaths are reported from India, Indonesia and Myanmar.

During 2008 total 2.5 million laboratory confirmed malaria cases and 3088 malaria deaths were reported in the region where as the estimated malaria cases and deaths were around 21 million cases and 29,000 respectively. Sri Lanka and DPR now entered in to malaria preelimination phase where as rest of the countries are still in control phase. In Maldives, there is no indigenous transmission since 1984 (World Malaria Report, 2008).

India: Before 1953 the incidence of malaria was very high (75 million / year). With introduction of NMCP and followed by NMEP the incidence was brought down to 50,000/ year in 1961. However, this success was not long lasting and resurgence of malaria was noted in 1970. With introduction of MPO in 1997 upsurge of malaria cases dropped and reached a plateau after 1984. About 1.65 million cases and 933 deaths were reported in 2003, approximately 22 percent of these cases were Falciparum malaria.

Malaria is prevalent in all the parts of the country except in areas more than 5000 feet above sea level. Some of the states are highly endemic for malaria and contribute about 90 percent of the total malaria in the country (Fig. 19.2). During 2008, the malaria incidence was around 1.53 million cases, 0.78 million Pf cases and 1055 eaths. About 88 percent of malaria cases and 97 percent of deaths due to malaria were reported from high disease burden states namely Northeastern (NE) States, Chhattisgarh, Jharkhand, Madhya Pradesh, Orissa, Andhra Pradesh, Maharashtra, Gujarat and Rajasthan, West Bengal and Karnataka. However, other States are also vulnerable and have local and focal outbreaks. Malaria problem has assumes serious dimension in NE states because of perennial malaria transmission, predominance of falciparum infection and development of drug resistance in the area

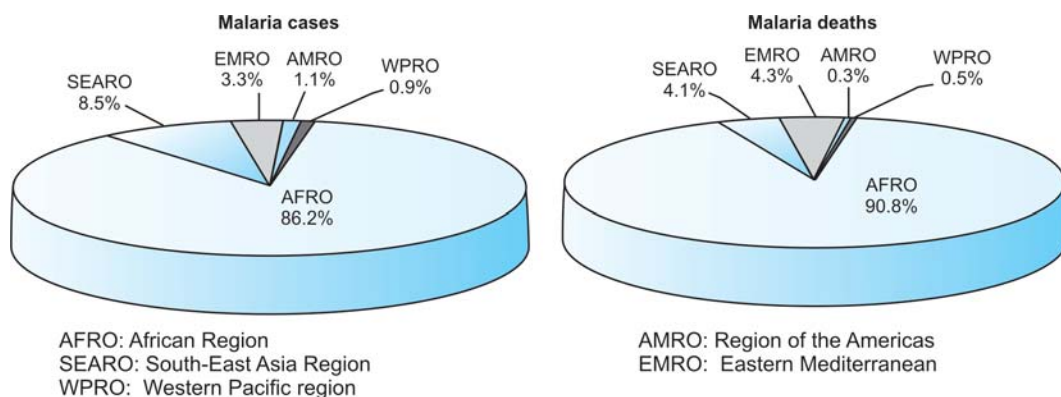


Fig. 19.1: Global malaria burden. Source: World Malaria Report 2008, WHO

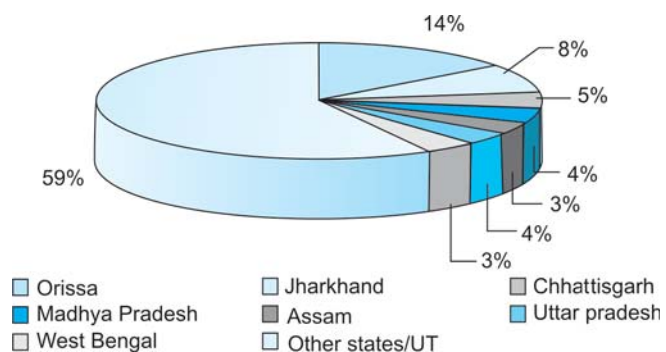


Fig. 19.2: Malaria cases in India (2008)¹⁶

TABLE 19.3: Malaria situation in India				
Year	Cases (in million)		Deaths	API
	Total	Pf		
2000	2.03	1.04	932	2.09
2001	2.09	1.01	1005	2.12
2002	1.84	0.90	973	1.82
2003	1.87	0.86	1006	1.82
2004	1.90	0.89	949	1.84
2005	1.82	0.81	963	1.68
2006	1.79	0.84	1707	1.66
2007	1.50	0.74	1311	1.39
2008	1.53	0.78	1055	1.36
2009	1.53	0.82	1068	—

The *epidemiological* picture of malaria in India may be summed up as follows.

- *Areas without malaria:* These are the areas more than 1830 meters above sea level.
- *Regions of variable endemicity:* The malaria here is seasonal and moderate in prevalence. These region consist of areas with extensive dry tracts of land.
- *Regions of epidemics:* The epidemics used to occur every 7 to 10 years in the pre-DDT era in the drier parts of North West India (Punjab, Haryana, Delhi, North West Uttar Pradesh) because of periodic unusual rainfall.
- *Regions of moderate to high endemicity:* These included the Gangetic planes in UP, Bihar, MP and the coastal regions of Maharashtra, Tamil Nadu and Orissa, where malaria occurs in a more or less static form.
- *Foothill regions of hyperendemicity:* These cover the lower Himalayan foothills in peninsular India including Assam and Indo-Burma border. *P. falciparum* infection is particularly common here.
- *Nonfoothill regions of hyperendemicity:* These are confined to the delta part of West Bengal, where the interference with natural flow of rivers leads to conditions favorable for mosquito breeding.
- *Urban malaria:* A special feature of urban malaria is that *A. stephensi* and *A. culicifacies* may also be responsible for transmission of malaria. It may be mentioned that *A. stephensi* breeds in wells and cisterns and also in several other fresh water collections.
- *Stable and unstable malaria:* When populations are continuously exposed to a fairly constant rate of malarial inoculations (entomological inoculation rate >10/year) they acquire partial immunity to the clinical disease. Severe manifestation of disease among such population is almost always confined to very young children, who suffer high parasite densities and acute clinical disease. This state is known as stable malaria. If untreated, this can progress very rapidly to severe and complicated malaria. However, adolescents and adults are partially immune and rarely develop severe malaria. Sometimes a state of infection without clinical sign and symptoms (asymptomatic parasitemia) is observed in adult and older children in area with stable malaria transmission called Premunition.

Assessment of Occurrence of Malaria

Both epidemiological and entomological surveys are used for this purpose. The respective indices used are described follows.

Epidemiological Indices

- *Proportional case rate:* It is the proportion of cases diagnosed as clinical malaria to the total number of cases attending a health set up, expressed as a percentage. It was as high as 20 percent in 1953.

- *Spleen rate:* Children from 2 to 10 years of age are examined for enlargement of spleen. Areas are classified according to endemicity, indicated by spleen rate, as below:

Below 10%	:	Nonmalarious
10 to 25%	:	Hypoendemic
25 to 40%	:	Endemic
Above 40%	:	Hyperendemic

The overall spleen rate was as high as 15.7 percent before 1953.

- *Blood surveys:* The main indices are:
 - *Infant parasite rate:* Blood of all infants under 1 year is examined and positivity rate is found. It is most sensitive index for recent transmission of malaria.

$$\text{Infant Parasite Rate} = \frac{\text{Number positive for malaria parasite (MP)}}{\text{Number of Blood slide examined from infants}} \times 100$$

- *Children parasite rate:* Blood of all children in age group 2 to 10 years is examined. The positivity rate was 3.9 percent before 1953.

$$\text{Child Parasite Rate} = \frac{\text{Number positive for MP}}{\text{Number of Blood slide examined from children}} \times 100$$

- *Annual parasite incidence (API):* As a result of the marked decrease in malaria, almost all the indices described above have lost their importance because they are relatively insensitive. The most common index used at present is the annual parasite incidence. It is defined as the number of confirmed malaria cases per thousand persons during the year in the community under surveillance. The API in 1995 was 3.29.

$$\text{API} = \frac{\text{Confirmed cases of malaria detected in one year}}{\text{Population under surveillance}} \times 1000$$

Sometimes, the trends in malaria are sought to be expressed by *Slide positivity rate (SPR)* which is the proportion of positive smears to total number of slides examined. However, it is important to remember that SPR often bears a direct relation to *ABER (Annual Blood Examination Rate)*, the latter being expressed as the number of slides examined per 100 population. An ABER of 10 per 100 population is essential because on this depends the statistical validity of parasite incidence.

- *Annual blood examination rate (ABER):* It is an index of operational efficiency of surveillance.

$$\text{ABER} = \frac{\text{Number of Blood smears examined during the year}}{\text{Population under surveillance}} \times 100$$

- Other indicators to study trend and burden of malaria are:
 - Slide falciparum Rate (SFR)
 - Annual falciparum rate (AFR)

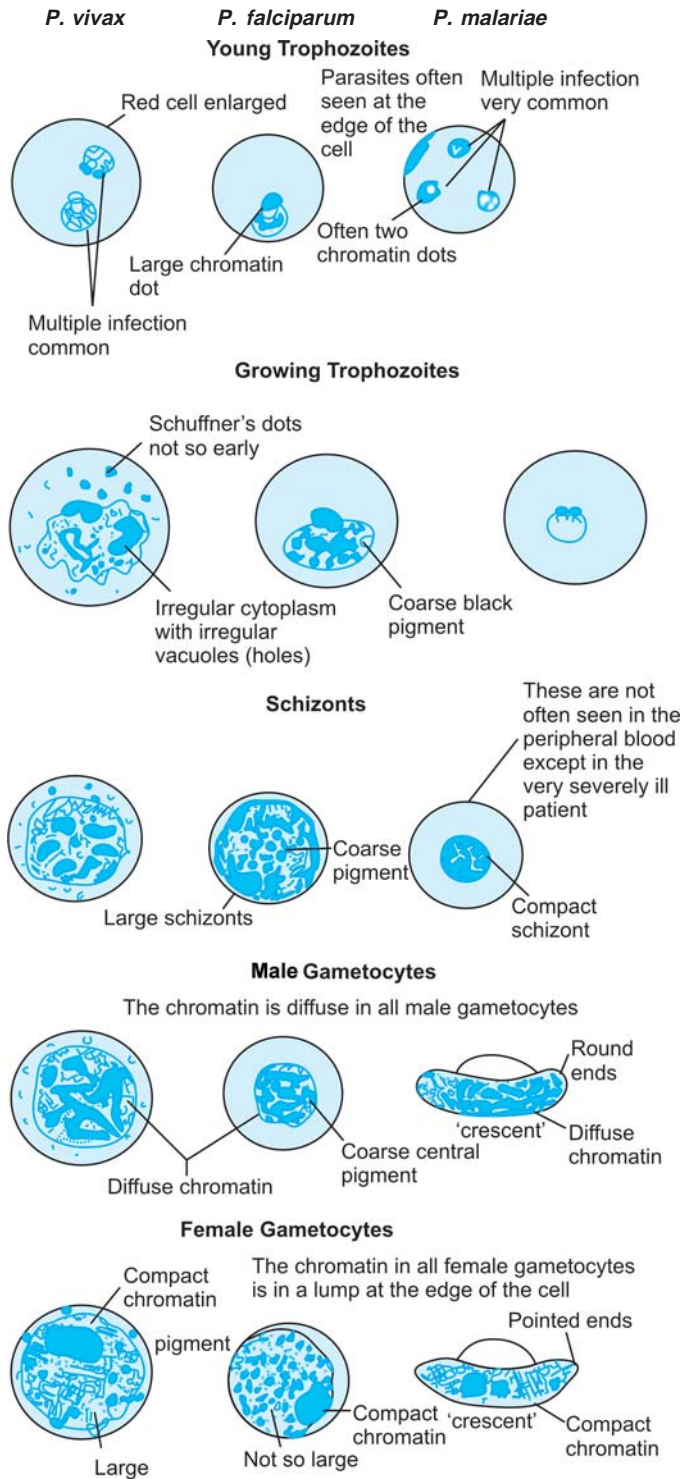


Fig. 19.3: Erythrocytic stages of malarial parasite

Entomological Indices

- Vector density:** Vector count is made according to species. It is usually expressed as per man hour (PMH) catch, i.e. the number of mosquitoes collected by one insect collector during one hour. The transmission of malaria depends upon mosquito density. The density which must be present before transmission of malaria becomes possible is called the critical density. The critical densities for important vector species are as follows **Table 19.4**.

TABLE 19.4: Vector species and density

Species	Critical density (catch PMH)
<i>A. culicifacies</i>	3.3
<i>A. stephensi</i>	3.3
<i>A. fluviatilis</i>	0.4
<i>A. minimus</i>	0.08
<i>A. philippinensis</i>	1.3
<i>A. sondaicus</i>	1.3

It may be mentioned that mosquito density and malaria prevalence are not directly associated. A recent survey conducted by the Malaria Research Center in Delhi revealed that, surprisingly, the API was higher (38.2 per 1000) in the relatively posh, mosquito free colonies of Delhi. It was found that the New Delhi Municipal Committee areas had an API varying between 13 and 25 per 1000, while it was less in the Delhi cantonment area and even lesser in Delhi Municipal Corporation area, which includes East Delhi. Though mosquitoes abound in East Delhi, these were mainly of the *Algyotibauses dengue* and *Culex quinquefasciatus* varieties, which do not carry the malarial parasite.

- Infected number:** The mosquitoes are dissected to find the percentage of infected ones, which are identified by the presence of oocysts in the stomach or sporozoites in the salivary glands.
- Annuals entomological inoculation rate (EIR):** It is average number of infectious bites by malaria-infected mosquitoes delivered to an individual human resident in the area in the period of one year. It indicates the rate at which people are inoculated with malaria parasites by mosquitoes (intensity of transmission). The proportion of infected mosquitoes in a locality is itself related to the number of infected and infectious humans living there. Therefore, lowering of the infectivity of infected persons to the mosquito vector will contribute to lowering of malaria transmission, and eventually to reducing the prevalence of malaria and the incidence of disease in that locality.

Bionomic Indices

These refer to the relationship of the carrier mosquitoes to the environment, specially in regard to their feeding and resting habits.

- Average number of larvae per dip:** This indicates the intensity of mosquito breeding, using a dipper method.
- Adult emergence rate:** This is determined by collecting the larvae and finding the proportion of adults that emerge from them in the laboratory. A typical rate is about 20 percent.

RESERVOIR

Man is the only important reservoir of human malaria. However, higher apes may also harbor *P. malariae*. Natural infection in monkeys is caused by several

plasmodium species such as *P. knowlesi*, *P. cynomolgi*, etc. These species can infect man but natural transmission is uncommon. Patients and convalescent carriers, having sexual forms in their blood, constitute the main reservoir of infection. A person must harbor mature and viable gametocyte of both sexes in sufficient density to act as successful reservoir.

MODE OF TRANSMISSION

The spread is indirect, occurring through a vector, the female anopheline mosquito. The characteristics of various anopheles species and their life cycle are shown in **Figure 19.3** and are shown in **Table 19.2**. When the female anopheles bites a patient or convalescent carrier having sexual forms (gametocytes) the latter are sucked along with blood into the stomach. The sexual cycle starts and is completed in the stomach wall, resulting in production of sporozoites which reach the salivary glands. The mosquito is now infective and causes infection by introducing sporozoites through the proboscis when a healthy person is bitten for another meal. After asexual cycles, sexual forms (gametocytes) are produced in his blood. These infect an anopheles mosquito when the latter sucks blood, and the whole cycle repeats itself. Sometimes infection can occur by other means, e.g. blood transfusion, needle stick injury, sharing needles, organ transplant, etc. Incubation period in such cases is shorter and there will be dormant hepatic infection and relapse. Mosquito born cases are known as autochthonous malaria to distinguish from cases transmitted by other means.

- Congenital malaria—infection passed from mother to fetus
- Induced malaria—infection passed from one individual to other through blood transfusion, sharing needles, organ transplant, etc.

Cryptic malaria—where route cannot be established after thorough investigation.

Overcrowding, warm temperature (20 to 30°C), humidity (60%) and medium rainfall are favorable factors for growth of vectors and transmission of malaria. Migration of population might help in spread of the disease.

INCUBATION PERIOD

Twelve days in *P. falciparum*, 14 days in *P. vivax* and 30 days in *P. malariae* infections.

PERIOD OF COMMUNICABILITY

As long as gametocytes remain in the blood, the person is infective. Inapparent infections are harbored for long periods depending upon the species of the parasite and the treatment given. Untreated or inadequately treated patients may be a source of mosquito infection for more

than 3 years in *P. malariae*, 1 to 2 years in *vivax* and to a maximum one year in *falciparum* infections. Those harboring gametocytes are infective to mosquitoes. The infected mosquito remains so for the rest of its life. Transmission can also occur by blood transfusion. Such infection can occur till asexual forms are present in the donor's blood. This period may be as long as 40 years or more in case of *P. malariae*. Stored blood remains infective only for 16 days.

SUSCEPTIBILITY AND RESISTANCE

Congenital transmission of parasite as well as antibody takes place through placenta. In immune mothers, antibody will prevent congenital malaria while infants born to nonimmune mothers may get infected. Such inherited passive immunity is short lived, hence infants and children are more susceptible to malaria than adults. Immunity is gradually acquired in endemic zones, so that the disease becomes rarer in local people after puberty. There is high mortality in *P. falciparum* infection. *P. malariae* and *P. vivax* infections, though more chronic, are nonfatal. Susceptibility is universal except in some African races. Most black Africans have a natural resistance to *P. vivax* infection, possibly related to the absence of Duffy factor in their erythrocytes. Also, persons with sickle cell trait have a milder parasitemia when infected with *P. falciparum*.

METHODS OF CONTROL

Global experience in malaria control over the past several decades suggests that control of malaria is a complex phenomenon and is dependent on several factors such as: (i) vector and parasite species prevalence, (ii) susceptibility/response of vectors to the control measures in operation, (iii) antimalarial drug choice, (iv) drug policy, (v) susceptibility of parasites to drugs, (vi) management of environmental conditions that influence vector and parasite prevalence, (vii) budgetary provision and finally, and (viii) the governmental policies in the implementation of available control measures.

We shall discuss here the methods of control in relation to the host, the agent and the environment. In other words, the methods of control include prevention of men from getting malaria, destruction of the malarial parasite in infected persons and environmental manipulation to control the mosquito vector.

Protection of the Host

This can be done by the following measures:

- Keeping the body well covered through use of socks, full sleeve shirts, etc.
- Use of mosquito nets and insecticide treated mosquito nets: Introduction of net treatment with pyrethroid insecticides of residual action has

considerably increased their effectiveness by adding killing action of the insecticide.

- Providing wire gauze doors to prevent entry of mosquitoes into the house.
- Applying mosquito repellents over exposed skin. Examples are citronella oil, dimethyl phthalate (DMP) cream, 2-ethylhexanediol, permethrin and 5 percent solution of diethyl toluamide.
- Spraying pyrethrum and synthetic pyrethroids like Rotenone to kill mosquitoes.
- Killing mosquitoes in the room with swatters
- Using electronic repellents.

Antimalarial vaccines: Sporozoites, merozoites and gametocytes are all antigenically distinct. Efforts are being made to develop vaccines against each of them. The work on a sporozoite vaccine is most advanced at present. However, from a practical point of view, it would be preferable to have a combined merozoite and sporozoite vaccine. It may be mentioned that a gametocyte vaccine would not benefit the infected person, but would prevent the transmission of disease. When available, it may be combined with the other two, providing a triple vaccine.

Destruction of the Agent

This is achieved through early case detection and prompt treatment.

Antimalarial drugs

The following antimalarial drugs are in current use:

- **4-aminoquinolines:** These are the drugs of choice for treatment of malaria. They have no prophylactic action and do not kill sexual forms, but surpass all other drugs in causing suppression of the asexual forms and slow attrition of gametocytes. Chloroquine is a good suppressant drug when given as a single dose of 4 tablets. Each tablet contains 150 mg of the base drug. For cure, it may be given as 4 tablets stat, 2 after 6 hours and then 1 bd for 2 days. A single dose of 4 tablets may be curative in semi-immune persons.

It is important to use chloroquine in correct dosage to obtain successful results. The WHO has recommended a total dose of 25 mg/kg, the doses on first, second and third day being 15, 5 and 5 mg/kg respectively. In practical terms, it works out to a standard course of 1500 mg for adults given as 4 tablets on first day morning, 2 tablets after 6 to 8 hours, then 2 tablets daily in the morning on the second and third day. An alternative schedule also effective, is 4 tablets on first, four tablets on second and 2 tablets on third day.

- **8-aminoquinolines:** Drugs of this series, such as primaquine and pamaquine, are used for radical treatment. They prevent relapse because of their powerful gametocidal action. Thus they control the spread of

the disease and are given after the suppressants such as mepacrine or chloroquine. Primaquine, a diphosphate salt, is the least toxic. The recommended dose is 15 mg daily for 10 to 14 days.

- **Dihydrofolate reductase inhibitors:** These include proguanil, pyrimethamine and trimethoprim. Proguanil (paludrine), as hydrochloride salt, has been used both for casual prophylaxis and cure. It acts on the tissue forms of parasite in the liver. It does not act directly on gametocytes but their development does not proceed beyond the ookinete stage if the patient has taken the drug. As a suppressant, it is slow and clears schizonts in 4 days. For treatment, one tablet (300 mg) is given by mouth daily for 5 to 10 days. One tablet weekly is taken for prophylaxis. It has few untoward effects. Pyrimethamine or daraprim is used mostly for prophylaxis in 25 to 50 mg weekly dose. As suppressant, a single dose of 25 to 50 mg is good enough, but not necessarily so in case of falciparum infection. A dose of 25 mg once a week for 8 weeks effects cure. It does not act on tissue forms. It has a prolonged suppressive effect on the schizonts.
- **Sulfonamides and sulfones:** A combination of sulfadoxine 500 mg and pyrimethamine 25 mg is available as Metakelfin in India. It is useful for treatment of patients infected with chloroquine resistant strains, particularly in cases of *P. falciparum*.
- **Mefloquine:** Mefloquine is a 4-methanolquinoline and is related to quinine. The drug is effective against all forms of malaria. Mefloquine is administered by mouth as the hydrochloride salt (250 mg base equivalent to 274 mg hydrochloride salt) in the form of tablets containing either 250 mg salt or 250 mg base. The dose is 25 mg/kg given in two parts at an interval of 6 to 24 hours.
- **Artemisinin-based combination therapy:** Artemisinin extracted from the leaves of *Artemisia annua* (sweet wormwood). It is a potent and rapidly acting blood schizontocide and is active against all *Plasmodium* species. In *P. falciparum* malaria, artemisinin also kills the gametocytes. Artemisinin has now largely given way to the more potent dihydroartemisinin and its derivatives, artemether, artemotil and artesunate. The three latter derivatives are converted to dihydroartemisinin.

TREATMENT OF MALARIA

National Anti-Malarial Program in India

The National Drug Policy on Malaria was first formulated in 1982 and has subsequently been reviewed and revised periodically. The present National Drug Policy for Malaria (2010) has been drafted keeping in view the availability of more effective antimalarial drugs and drug resistance status in the country.

The objectives of an antimalarial treatment are to ensure rapid clinical and parasitological cure of malaria, reduce morbidity and mortality, including malaria-related anemia, prevent the progression into severe and potentially fatal disease, reduce the impact of malaria infection on the fetus during pregnancy, reduce the reservoir of infection, interrupt transmission through gametocytocidal clearance of host, prevent the emergence and spread of drug resistance and prevent malaria in travelers.

Early diagnosis and complete treatment is one of the key strategies of the National Malaria Control Program. All fever cases clinically suspected of malaria should be investigated for confirmation of malaria by either microscopy or Rapid Diagnostic Test (RDT) before treatment is started. At present, only Pf RDT are being supplied under National Vector Borne Disease Control Program (NVBDCP) **Table 19.5**.

Treatment solely on the basis of clinical suspicion should only be considered when a parasitological diagnosis is not accessible. In high Pf predominant areas where it is not possible to get microscopy results within 24 hours, ASHAs /other community health volunteers/MPWs should be provided with rapid diagnostic kits and antimalarials (including ACT) for early diagnosis and treatment of Pf cases. Presumptive treatment with chloroquine is no more recommended.

Treatment of Uncomplicated Malaria

Uncomplicated malaria present with signs and symptoms of infection together with evidence of malaria parasitemia but without signs of severity and/or evidence of vital organ dysfunction. The objective of treating uncomplicated malaria is to cure the infection (eradication of parasite from the body). The public health goal of treatment is to reduce transmission of the

infection to others in the community (reduction of reservoir of infection) and to prevent the emergence and spread of resistance to antimalarial drugs. The treatment will depend upon the species of *Plasmodium* diagnosed.

P. vivax cases should be treated with chloroquine for three days and Primaquine for 14 days. Primaquine is used to prevent relapse but is contraindicated in pregnant women, infants and individuals with G6PD deficiency. Patients should be instructed to report back in case of hematuria or high colored urine / cyanosis or blue coloration of lips and Primaquine should be stopped in such cases. Care should be taken in patients with anemia (**Table 19.6**).

Artemisinin-based combination therapies (ACT) should be used for the treatment of uncomplicated *P. falciparum* malaria. ACT is a combined therapy of an artemisinin derivative with a long acting antimalarial (amodiaquine, lumefantrine, Mefloquine or sulfadoxine-pyrimethamine). The ACT used in the national program in India is artesunate + sulfadoxine-pyrimethamine (SP). Presently, Artemether + Lumefantrine fixed dose combination and blister pack of artesunate + mefloquine are also available in the country (**Table 19.7**).

TABLE 19.6: Age-wise dosage schedule for treatment of *P. vivax* cases

Age(Years)	Tablet chloroquine (150 mg base)			Primaquine (2.5 mg base)
	Day 1	Day 2	Day 3	Day 1 to Day 14
< 1	Nil	Nil	Nil	Nil
1-4	7.5	1	2.5	1
5-8	15	2	5.0	2
9-14	30	4	10.0	4
15 and above	45	6	15.0	6

TABLE 19.5: Drug schedule for treatment of malaria under NVBDCP 2010 in India

Diagnosis	Treatment
<i>P. vivax</i> cases	§ Chloroquine: 25 mg/kg body weight divided over three days (10 mg/kg on day 1, 10 mg/kg on day 2 and 5 mg/kg on day 3) § Primaquine: 0.25 mg/kg body weight daily for 14 days.
Uncomplicated <i>P. falciparum</i> cases	Artemisinin based Combination Therapy (ACT) § Artesunate 4 mg/kg body weight daily for 3 days plus § Sulfadoxine (25 mg/kg body weight) and Pyrimethamine (1.25 mg/kg body weight) on first day and § Single dose primaquine preferably on day 2
Pregnant women with uncomplicated Pf infection	1st Trimester: Quinine salt 10 mg/kg 3 times daily for 7 days 2nd and 3rd Trimester: ACT as per dosage given above.
Treatment of mixed infections (Pv + Pf)	Full course of ACT and Primaquine 0.25 mg per kg body weight daily for 14 days
Clinical malaria (where parasitological diagnosis not available or delayed)	Suspected malaria cases will be treated with full course of chloroquine, till the results of microscopy are received. When parasitological diagnosis is available, species-specific treatment should be administered.

TABLE 19.7: Age-wise dosage schedule for treatment of *P. falciparum* cases

Age (Years)	Day 1		Day 2	Day 3	Day 4
	Artesunate (50 mg)(50 mg)	SP*	Artesunate (50 mg)	Artesunate (50 mg)	Primaquine (7.5 mg base)
< 1	½	¼	½	½	Nil
1-4	1	1	1	1	1
5-8	2	1½	1	2	2
9-14	3	2	1½	3	4
15 and above	4	3	4	4	6

* Each Sulphadoxine-Pyrimethamine (SP) tablet contains 500 mg Sulphadoxine and 25 mg Pyrimethamine

SEVERE MALARIA

Severe manifestations can develop in *P. falciparum* infection over a span of time as short as 12 to 24 hours and may lead to death, if not treated promptly and adequately. Severe malaria is characterized by one or more of the following features:

- Impaired consciousness/coma
- Repeated generalized convulsions
- Renal failure (Serum Creatinine >3 mg/dl)
- Jaundice (Serum Bilirubin >3 mg/dl)
- Severe anemia (Hb <5 g/dl)
- Pulmonary edema /acute respiratory distress syndrome
- Hypoglycemia (Plasma Glucose <40 mg/dl)
- Metabolic acidosis
- Circulatory collapse/shock (Systolic BP <80 mm Hg, <70 mm Hg in children)
- Abnormal bleeding and DIC
- Hemoglobinuria
- Hyperthermia (Temperature >104° F)
- Hyperparasitemia (>5% parasitized RBCs in low endemic and >10% in hyperendemic areas)

Fetal and maternal complications are more common in pregnancy with severe malaria; therefore, they need prompt attention.

Treatment of Severe Malaria Cases

Severe malaria is an emergency and treatment should be given as per severity and associated complications, which can best be decided by the treating physician. The primary objective of antimalarial treatment in severe malaria is to prevent death. The guidelines for specific antimalarial therapy is as below:

Artesunate: 2.4 mg/kg body weight IV or IM given on admission (time = 0 h); then at 12 h and 24 h and then once a day.

(or)

Artemether: 3.2 mg/kg body weight IM given on admission and then 1.6 mg/kg body weight per day.

(or)

Arteether: 150 mg IM daily for 3 days in adults only (not recommended for children).

(or)

Quinine: 20 mg/kg* body weight on admission (IV infusion or divided IM injection) followed by maintenance dose of 10 mg/kg body weight 8 hourly. The infusion rate should not exceed 5 mg salt/kg body weight per hour.

Note: The parenteral treatment in severe malaria cases should be given for minimum of 24 hours once started (irrespective of the patient's ability to tolerate oral medication earlier than 24 hours).

After parenteral artemisinin therapy, patients will receive a full course of oral ACT for 3 days. Those patients who received parenteral Quinine therapy should receive:

- Oral Quinine 10 mg/kg body weight three times a day for 7 days (including the days when parenteral Quinine was administered) plus Doxycycline 3 mg/kg body weight once a day or Clindamycin 10 mg/kg body weight 12 hourly for 7 days (Doxycycline is contraindicated in pregnant women and children under 8 years of age).

(or)

- ACT as described.

Resistance should be suspected if in spite of full treatment with no history of vomiting, diarrhea, patient does not respond within 72 hours, clinically and parasitologically. Such cases not responding to ACT should be treated with oral quinine with Tetracycline/ Doxycycline and should be reported to concerned level for initiation of therapeutic efficacy studies.

Chemoprophylaxis

As chloroquine is no longer considered an effective treatment for falciparum malaria in most areas of India, it is no longer recommended for chemoprophylaxis.

(*loading dose of Quinine, i.e. 20 mg/kg body weight on admission may not be given if the patient has already received quinine or if the clinician feels inappropriate).

Chemoprophylaxis is no longer recommended as a routine method of prevention in pregnancy. Use of personal protection with insecticide-treated are recommended for pregnant women and long-term travelers in India.

Use of chemoprophylaxis is limited to the following two situations:

1. Short-term travelers/tourists (less than 6 weeks) from nonmalarious areas to malarious areas. Drug of choice is Doxycycline 100 mg daily in adults and 1.5 mg/kg daily in Children. The drug should be started 2 days before travel and continued for 4 weeks after leaving the malarious area. It is not recommended for pregnant women and children less than 8 years.
2. Long-term travelers where appropriate, e.g. military and paramilitary troops on night patrol duty, etc. in malarious areas. The drug of choice is Mefloquine 250 mg weekly for adults and 5 mg/kg for children once a week; beginning 1 week before and continued up to 4 weeks after exposure. Mefloquine is contraindicated in cases with history of convulsions, neuropsychiatric problems and cardiac conditions. Necessary precautions should be taken and all should undergo screening before prescription of the drug.

Drug Resistance

Widespread and indiscriminate use of antimalarials can cause high levels of resistance. Resistance can be prevented, or slowed considerably, by combining antimalarials with different mechanisms of action and ensuring very high cure rates through full adherence to correct dose regimens. Antimalarial drug resistance has been defined as the “ability of a parasite strain to survive and/or multiply despite the administration and absorption of a drug given in doses equal to or higher than those usually recommended but within tolerance of the subject”. Drug resistance can cause ‘treatment failure’ but all ‘treatment failure’ is not due to drug resistance; it may occur due to numbers of factors like incorrect dosing, noncompliance with duration of dosing regimen, poor drug quality, drug interactions, poor or erratic absorption, and misdiagnosis, etc.

Global Distribution of Resistance

Resistance to antimalarials has been documented for *P. falciparum*, *P. malariae* and *P. vivax*. Malaria parasites have demonstrated some level of resistance to almost every antimalarials drug currently available. In *P. falciparum*, resistance has been observed in all currently used antimalarials (amodiaquine, chloroquine, mefloquine, quinine, and sulfadoxine-pyrimethamine)

and, more recently, in artemisinin derivatives. The geographical distributions and rates of spread have varied considerably.

Mechanisms of Antimalarial Resistance

Resistance appears to occur through spontaneous mutations of parasite that confer reduced sensitivity to a given drug or increased capacity for the parasite to expel chloroquine at a faster rate that does not allow chloroquine to act effectively.

Detection of resistance: The following methods have been routinely used to study or measure antimalarial drug resistance:

- *In vivo* test: the test consists of the treatment of a group of symptomatic and parasitemic individuals with known doses of drug and the subsequent monitoring of the parasitological and/or clinical response over time. The tests required a period of follow-up (7 to 14 days) after administration of the antimalarial drugs and note the clinical and parasitological response to drugs. The response to treatment is categorized into RI, RII, and RIII class based on parasitological grounds and also clinical response.
- *In vitro* test: The test require to remove parasites from the host and place them into a controlled experimental environment and observe the response of drug for inhibition of maturation of parasites into schizont.
- Animal model studies: The test is conducted in non-human lab-reared animals for assessing a new experimental drug that is not yet approved for humans use.
- Molecular characterization: Molecular tests use polymerase chain reaction (PCR) to indicate the presence of mutations encoding biological resistance to antimalarial drugs.

Sensitivity (S): Clearance of asexual parasitemia within 7 days of initiation of treatment without subsequent recrudescence.

Resistance

- R I Clearance of asexual parasitemia within 7 days followed by recrudescence
- R II Marked reduction of asexual parasitemia but no clearance
- R III No marked reduction in asexual parasitemia.

Vector Control

This pertains to measures aimed at killing mosquitoes and preventing their breeding. These have been described earlier in the chapter on “Biological Environment” (Chapter 11).

OUTLINE OF VECTOR CONTROL METHODS

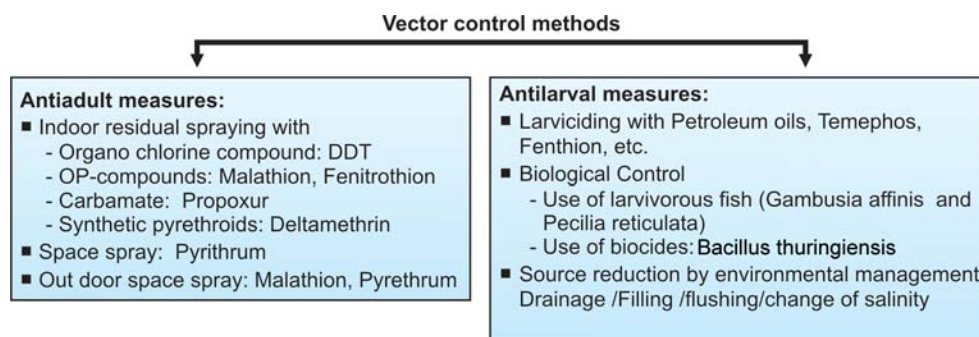


TABLE 19.8: Major malaria control activities and programme in India

<i>Problem status and initiative taken</i>	<i>Program and projects with salient features</i>
Before 1953 there was 75 million cases and 0.8 million deaths in India. Introduced NMCP (1953) to combat problem of malaria	'National Malaria Control Program' (NMCP) 1953 Objectives: To bring down malaria transmission to a level at which it would cease to be a major public health problem and hold down malaria transmission at low level. Strategies: 1) Anti-malarial treatment for institutional cases, 2) Residual insecticide spray with DDT of human dwelling and cattle sheds
Encouraged by success of NMCP (2 million cases per year in 1958) eradication program was take-up in 1958	'National Malaria Eradication Program' (NMEP) attempted ending transmission of malaria by killing entire vectors and elimination of reservoir of infections. Strategies: 1) Two round of DDT spray in all area, 2) Active and passive surveillance, 3) Presumptive and Radical treatment
NMEP reduced cases to 0.1 million in 1966, but set back resulted subsequently due to <i>technical, operational</i> and <i>administrative</i> failures. Resurgence of malaria cases and deaths were noted. Attempt of malaria eradication was given up and introduced MPO .	'Modified Plan of Operation' (MPO) 1977 was launched. Vertical approach was replaced by horizontal approach. Objectives: Elimination of deaths, reduction of morbidity from malaria and maintenance of the gains achieved so far by reducing transmission of malaria Strategies: 1) Stratification of rural area based on API and differential vector control measures 2) Active and passive surveillance, 3) Presumptive and radical treatment
The implementation MPO, Urban Malaria Scheme in 1971-72, and Pf containment programme in 1977 reduced malaria incidence, controlled death but resurgence continued in some area. Expert committee analyzed epidemiological parameters for malaria transmission in the country	Malaria Action Program (MAP) 1995: <ul style="list-style-type: none"> • Divided areas into high risk and low risk area based on certain epidemiological. • Priority spray operation and differential treatment for high-risk area • Identified following problem area areas were identified: Hard core (tribal) areas, Epidemic prone areas, Project areas, Triple insecticide resistant areas, Urban areas.
Annually 2-3 million cases were reported during 1984 –1998. The area with adverse epidemiological parameter were selected for implementation of EMCP	'Enhanced Malaria Control Project' (EMCP) 1997 Objectives of EMCP: Prevention of death and reduction of morbidity from malaria, consolidation of the gain achieved so far. Strategies: Early case detection and prompt treatment, vector control by appropriate insecticide, health education and community participation.
In 1999 name of national program was changed	National Anti Malarial Program (NAMP) 1999: Objectives and strategies remained same as MAP
Though NAMP successfully reduced the average national API but some areas continue to register high API.	The Intensified Malaria Control Project (IMCP), 2005 was introduced with special inputs in the form of Rapid Diagnostic Tests (RDTs), Artesunate Combination Therapy (ACT), Insecticide Treated Bed Nets (ITNs) and Health Systems Strengthening (HSS) were provided.
2003-04	Convergence of numbers of vector borne programs: Malaria, Filaria, JE and Dengue under National Vector Borne Disease Control Programme (NVBDCP). Strategies: Integrated vector control and promotion of insecticide treated bed net
2006	ACT introduced in areas showing Chloroquine resistant falciparum malaria.

Malaria Control Activities and Program in India

National program for malaria in India has been evolved over the year salient features of which has been described in the following **Table 19.8**.

National Anti Malaria Programme

National Anti Malarial Program (NAMP) 1999 has many common features to earlier program. Presently the antimalarial activities are being carried under National Vector-Borne Disease Control Program (NVBDCP), which an umbrella programmes for prevention, and control of Vector-Borne Diseases (VBDs). The overall strategy under NVBDC on prevention and control of malaria is outlined below.

Two Objectives of the Program are:

1. Prevention of deaths and morbidity due to malaria
2. Maintenance of ongoing socioeconomic development

Specific Objectives:

- To bring down API to 1.3 or less in the 11th Five Year Plan
- At least 50 percent reduction in mortality due to malaria by the year 2010, as per National Health Policy (2002)
- To halt and reverse the incidence of malaria by 2015 (as per Millenium Development Goals)

Strategies: The strategies for prevention and control of malaria and its transmission are:

Surveillance and Case Management

- Case detection (passive and active)
- Early diagnosis and complete treatment
- Sentinel surveillance

Integrated Vector Management (IVM): refer vector control for details

Stratification of the problem: Under Modified Plan of Operation the malarious areas of the country have been stratified according to Annual Parasite Incidence (API) as follows.

- Area with $API < 2$
- Area with $API \geq 2$

The approach was used to define population at risk and for judicious use of resources.

Selective application of transmission control measures in these strata were as follows:

Intervention in area with $API \geq 2$:

- Residual insecticide spray with 2 round DDT or 3 round BHC/ Malathion
- Surveillance/ Treatment of cases
- Entomological assessment

Intervention in area with $API < 2$:

- Focal spray around house with Falciparum
- Surveillance/ Treatment of cases

- Epidemiological investigation
- Follow-up

Community Participation

- Sensitizing and involving the community for detection of Anopheles breeding places and their elimination
- NGO schemes involving them in program strategies

Behavior Change Communication (BCC)

BCC has been defined as a process of learning that empowers people to take rational and informed decisions through appropriate knowledge. BCC as a supportive strategy should be an integral part of malaria control program. It enhances awareness regarding transmission risk reduction, treatment and availability of services at different levels. Communicating messages for behavioral changes are formulated after analysis of health behavior of people. Clear messages, communicated through different, credible channels are most likely to bring about change. It inculcates necessary skills and optimism; facilitates pertinent action through changed mindsets, modified behavior.

Monitoring and Evaluation of the program

Monitoring is ongoing follow-up of the planned program activities / processes to examine whether the program is being implemented as planned. Monitoring provides feedback information for corrective action. Evaluation indicate the extent of achievement of the stated objectives goals in defined time-periods, and why it may have succeeded or failed. Evaluations are expected to lead to modification of program design and policies.

SURVEILLANCE AND CASE DETECTION

It relied on surveillance of fever cases in the community by means of active fortnightly case detection based mainly on slide results conducted mainly by the multi purpose worker or other health functionaries. There are different approaches to search for cases:

- *Passive case detection:* Collection of blood slides from all fever cases in all medical or health units to detect malaria cases. This is followed by appropriate treatment. This also includes notification of all confirmed or suspected cases of malaria.
- *Active case detection:* It is the system of detecting malaria cases by domiciliary visits. Under antizmalarial program the health workers collect blood slide from all fever cases by fortnight visits in community (secondary cases occur within two weeks following primary cases). A patient with fever and no other obvious cause of fever is considered a case of "suspected malaria. The health worker during house-to-house visits inquires about fever cases in the family and initiates a diagnostic test (slide microscopy, RDT) if he or she encounters a suspected case of malaria; the health worker also provides case management.

- *Mass blood survey*: Examination of blood from all persons in a community. This is carried out during epidemiological investigation around positive cases. This is also done to detect asymptomatic parasitemia.

Sentinel Surveillance

Sentinel surveillance is necessary for events which are not being captured by the regular system of reporting viz. severe cases of malaria, their management and on malaria deaths and effectiveness of the antimalarial drugs being used. The objective of sentinel surveillance is to capture trends on in-patient malaria, severe malaria and malaria deaths. It will also enable the program to estimate the malaria burden in the country. Medical college or any other hospital with required facilities and staff may act as sentinel site.

DIAGNOSIS AND TREATMENT OF MALARIA

Any fever suspected as case malaria, must be investigated by Microscopy of blood for malarial parasites and/or Rapid Diagnostic Test and antimalarial treatment is given only on the basis of a positive diagnosis. A patient with fever in an endemic area during transmission season, or who has recently visited an endemic area, without any other obvious cause of fever as stated below should be considered as *suspected case of malaria*:

- Cough and other signs of respiratory infection
- Running nose and other signs of cold
- Pelvic inflammation indicated by severe low back-ache, with or without vaginal discharge and urinary symptoms
- Skin rash suggestive of eruptive illness
- Burning micturition
- Skin infections, e.g. boils, abscess, infected wounds
- Painful swelling of joints
- Diarrhea
- Ear discharge

In practice the ascertainment of an “obvious cause” can only be expected from well-trained and experienced health staff. A volunteer or health activist working in a high-risk area should be taught to consider any fever case in the absence of specified symptoms as suspected malaria.

The area lacking timely microscopic services (result is not available within 24 hours of testing) and reporting > 30 percent of Pf, SfR >1 percent, consistently high API and deaths, difficult to access area are provided with Rapid Diagnosis Test kit for prompt diagnosis of Pf cases. To ensure the accessibility of service and availability of antimalarial drugs to people DDC (Drug Distribution Centre), FTD (Fever Treatment Depots), MLV (Malaria Link Volunteers) have been established through community involvement. At FTD antimalarial treatment

is given along with investigation for the case but in DDC there is only provision of distribution of antimalarial drug. Details diagnosis and treatment have been described in previous sections.

URBAN MALARIA CONTROL ACTIVITIES

About 7.8 percent of the total cases of malaria are reported from urban areas. *Anopheles stephensi* is the important vector of Urban Malaria. The mostly breeds in container, piped water supply system, overhead and storage tanks, water storage at construction sites, wells, etc. *Aedes aegypti* and *Culex quinquefasciatus* are also important vectors in urban area.

Factor Responsible for Urban Malaria Problem

- Unplanned developmental activities
- Increasing migration leading to dissemination of infection: The movement may lead to permanent change of residence known as migration or there may be temporary change of residence and followed by return to the original location which is termed as circulation. Both these phenomena can influence local malaria epidemiology, i.e. transmission and its seasonal pattern.
- Proliferation of slums with no basic amenities leading to abundant mosquito-genic conditions.
- Anti larval activities are restricted to chemical control. The focus is not on integrated source reduction measures.
- Area and population of the towns/cities have increased manifold without commensurate increase in manpower for delivery of services including health care.

Urban Malaria Scheme (UMS) was sanctioned in 1971 after the recommendations of Madhok Committee in 1969. The main activity of UMS is reduction of vector population in urban areas through recurrent anti larval measures.

Two main objectives:

1. To prevent deaths due to malaria.
2. Reduction in transmission and morbidity

The *control measures* recommended under UMS are as follows:

- Early diagnosis through passive institutional surveillance (malaria clinic, dispensary and hospital) and treatment.
- Vector control strategy:
 - Antilarval! Malarial oil, Malathion, Fenthion, Abate
 - Engineers, measure like filling, under ground drainage
 - Biological control by Larvivorous fish (*Gambusia affinis* and *Pecilia reticulata*)

- IEC:
 - Awareness campaign program-observe malaria week
 - Anti-adult – Space spraying with Pyrethrium only to peripheral belt of town (1/2 to 1 mile)
- Legislative measures:
 - Model civic bye-laws and Building bye-laws: Promulgation and implementation with provisions to prevent/eliminate mosquito breeding in any premises or during and after construction work.

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Filariasis (ICP-B74.9)

Filariasis, though not fatal, is an important public health problem because of the following reasons:

- There is a social stigma attached to it. The swelling of elephantiasis produce disfiguration, resulting in matrimonial handicap and inferiority complex.

- Physical disabilities due to obstructional defects (such as swelling of genitals and legs or chylous ascites) result in loss of manpower. An example is the coir industry in Kerala.
- Filariasis is one communicable disease which is increasing in extent in India, because drainage facilities are not keeping pace with the rapidly increasing water supply in towns and villages. Thus it is spreading to areas previously free from the disease. For example, surveys in Palghat town, Kerala, revealed prevalence rates of 0 percent, 4.3 percent and 5.3 percent in 1950, 1960 and 1966 respectively.¹
- A large number of infections remain symptomless; they form a potent source for the spread of infection. In a study in Sri Lanka, 32 percent subjects were found to remain symptomless carriers.¹

Identification

Filarial infection refers to the presence of the filarial parasites of any stage and sex in the human host. At present, the detection of microfilaria is the only definite method for demonstrating infection. Around 90 percent of MF carriers are asymptomatic. Filarial disease refer to the presence of clinical manifestations, i.e. acute adenolymphangitis, epididymoorchitis, lymphedema, hydrocele, etc. In epidemiological practice these manifestations (irrespective of patent microfilaremia) are assumed to be of filarial origin in endemic areas. A host of other clinical entities have been reported to be caused by filarial infections. Of these, glomerulonephritis, arthritis and endomyocardial fibrosis are probably of practical importance.²

Clinical features may be classified as:

- **Allergic:** Eosinophilic lung (tropical eosinophilia) indicated by eosinophilia, chronic bronchitis and asthma.
- **Inflammatory:** Acute (such as lymphangitis of the legs and genitals) and chronic (such as lymphadenitis in inguinal and femoral regions) due to worms and secondary infection, especially streptococcal. Lymph nodes due to local tissue reaction around dead worms are often seen after treatment with diethylcarbamazine.

Acute adenolymphangitis: Usually involves extremities and external genitalia, with associated recurrent fever. Acute episodic filarial fever attacks are the most important cause of loss of work due to filariasis. Increased frequency of these attacks is associated with progression of lymphedema. Secondary bacterial infections, particularly with beta hemolytic streptococci, can occur. Funiculitis and orchitis are also commonly seen. Regional adenitis is fairly common.

- **Obstructional:** Soft edematous swelling due to blockage of lymphatics followed by fibrotic changes give rise to the picture of elephantiasis. Soft or hard

swellings of testes (hydrocele), legs and feet are common. Sometimes arms, breasts, vulva and penis are also involved. Hydrocele is rare and elephantiasis less marked in *Brugia* infections. The former may be found in up to 20 percent cases of *W. bancrofti* infection. Chyluria and chylous ascites occur if bladder or peritoneal lymphatics get blocked and ruptured. As per present knowledge, the microfilariae are not responsible for the obstructive lesions in the lymphatics and the lymph nodes, leading to lymphoedema, are attributed to developing worms (i.e. L3 and L4 stages), which are relatively short lived but which both undergo a moult, and to the young adult stage developing up to and including the fertile adult male and female worms.

Lymphedema is Classified as

- Grade I: Mostly pitting edema; spontaneously reversible on elevation.
- Grade II: Mostly nonpitting edema; there is no spontaneous reversion on elevation.
- Grade III: Stage of elephantiasis; there is gross increase in volume in a Grade II swelling accompanied by dermatosclerosis and papillomatous lesions.³

Nonspecific symptoms like headache, dizziness, drowsiness, conjunctivitis, precordial pain, wheeze, acute spasmodic abdominal pain localised in right iliac fossa and recurrent swelling of salivary glands have also been reported in filariasis.

Occult filariasis: In occult filariasis, clinical manifestations are not present and microfilariae are not detected in blood, though they may be found in the tissues. Tropical pulmonary eosinophilia, TPE, is now considered a classical example of occult manifestations. Males suffer twice as commonly compared to females. TPE is rare in children. Extrapulmonary manifestations may be seen in 15 percent. TPE should be differentiated from similar severe reactions seen due to nonhuman types of filarial worms which are not able to develop in the human host.³

The mystery that remains to be solved is why some patients with microfilaremia remain asymptomatic for many years while others develop elephantiasis and hydrocele early in the course of disease.

A 4½ years study of filariasis in East Godavari district of Andhra Pradesh⁴ revealed that nearly half the manifestations in males and three-fourths in females occurred in the lower extremities. 21.1 percent manifestations in males involved the genitals. Swelling of breast and chyluria were rare. Lymphadenitis accounted for 65.1 percent of acute manifestations. 10.7 percent apparently healthy persons, 15.8 percent microfilaria carriers and 39.7 percent chronic cases showed acute manifestations. The number of chronic

cases was three to five times more than that of persons with acute disease. The youngest age recorded for microfilaremia, acute and chronic disease was 8 months, 13 months and 28 months respectively.

The sequence of events and the proportion of individuals who progress from one clinical stage to the next are unknown. It is generally thought that the adult worms are responsible for the clinical manifestations. These manifestations are characterized by acute adenolymphangitis, usually accompanied by fever and by chronic obstructive lesions that develop years later, often after repeated acute attacks. The mechanisms underlying these manifestations are poorly known.

Differences in the anatomical distribution of the clinical manifestations of brugian and bancroftian filariasis may be due in part of different tropism of the parasite for particular anatomical locations. In *Brugia*, genital manifestations are not common as contrasted to *W. bancrofti*. Even with *W. bancrofti* genital lesions are common in Northern India as against the limb lesions in South India. In *W. bancrofti* endemic areas, swelling of the leg often involves the thigh as well as the lower legs, while in *B. malayi* infections only the portion of the leg below the knee appears to be swollen.³

Diagnosis of filariasis is made by direct blood examination and by immunological tests (ELISA). Microfilariae may also be found in the fluid from lymphatic swellings. Blood examination is done by preparing thick or thin films or by using hemolyzed blood in a counting chamber. Microfilariae are best detected during maximal periods of microfilaremia (during the night), especially after a provocative dose of diethylcarbamazine.⁵ Among immunological tests, Sawada antigen skin test developed in the sixties has been used by several workers. This test becomes positive early in the course of disease. In one study in an endemic area, almost all the inhabitants had become positive for this test while only a third had revealed microfilariae in blood.¹ The Sawada antigen is prepared from the adult *Dirofilaria immiter*, the filarial parasite in dog's heart. Higashi's larval antigen prepared from infective *W. bancrofti* larvae has been found to be more specific with fewer false positives. A SAFA (Soluble Antigen Fluorescent Antibody) test has also been found useful to detect serum antibodies in filariasis. An ELISA kit (Fila test) for diagnosis of filariasis has also been developed.

When microfilaremia is strongly suspected in a patient but blood examination is repeatedly negative, diagnosis may be confirmed by allowing infection free mosquitoes to feed on the patient and by demonstrating the infection in mosquitoes after 2 weeks. This technique is known as xenodiagnosis.⁶

INFECTIOUS AGENT

Strictly speaking, the term filariasis can be used for human infection caused by any one of the following

slender, thread like worms: *Wuchereria bancrofti*, *Brugia malayi*, *B. timori*, *Loa loa*, *T. perstans*, *T. streptocerca*, *M. ozzardi* and *Onchocerca volvulus*. However, the term filariasis is conventionally used only for the first three. *B. timor* has a limited distribution and is not found in India. Adult forms are never found in the peripheral circulation. The only types found in India are the nocturnally periodic *W. bancrofti*, diurnally subperiodic *W. bancrofti* (only one pocket) and *B. malayi*. More than 98 percent filariaries in India is due to *W. bancrofti*.⁷ *W. bancrofti* is found all over India while *B. malayi* is found mainly in Kerala and Orissa. The former is found both in urban and rural areas and the latter mainly in the rural areas. Male and female worms remain coiled together in lymph vessels, lymph glands and thoracic duct. The male measures 40 mm × 0.1 mm, while the female is almost double in size. The female delivers embryos, not ova, which are sheathed and pass into the bloodstream. The lifespan of the adult is 5 to 10 years.

Embryos (microfilariae), 280 × 7 millimicron in size, appear structureless when seen in the living state. Details are made out on staining. The sheath, permitting wriggling movements, is longer and protrudes as an empty sac at both ends. The middle third portion is granular. The body appears to be composed of closely packed nucleated cells which stop short of the tip of the tail. They pass through capillaries with difficulty.

A difference in the periodicity of infection in the peripheral blood leads to further division of both types into two distinct forms—periodic and subperiodic.⁸ Periodic *W. bancrofti*, showing highest concentration at night from 9 pm and 2 am) is the species found in India while subperiodic form, which tends to appear in the peripheral blood throughout the day with a small peak in some part of the day, is found in South Pacific only. Periodic nocturnal and subperiodic, both forms of *B. malayi* are found in Orissa and Kerala. In nocturnal periodic form periodicity can be reversed by making the carrier sleep during the day. The number of microfilariae in blood is increased by sleeping and reduced by physical exertion. The lifespan of microfilaria is about 2 months. Development of clinical disease leads to disappearance of microfilaria (**Fig. 19.4**).

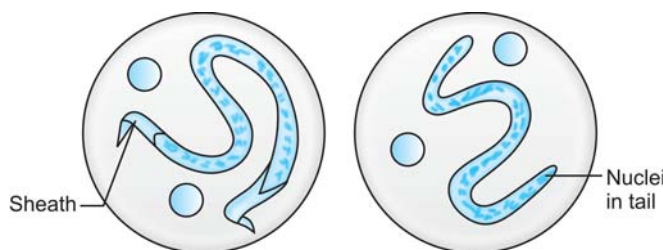


Fig. 19.4: Microfilaria of *W. bancrofti*

Life Cycle in the Mosquito

The following four larval stages are seen in mosquitoes:

1. *Microfilariae*: These are found in the stomach soon after the meal but the mosquito is not recorded as infected till it starts development in the thoracic muscles. It casts off the sheath in 1 to 2 hours.
2. *First stage larva*: In two days, the microfilaria becomes short, sluggish and sausage shaped and is confined to thoracic muscles.
3. *Second stage larva*: The length increases. The larva becomes inactive and is confined to thoracic wall.
4. *Third stage larva*: It is very active and may be found in any part of the mosquito. This is the infective stage. The larva is 0.5 mm long and looks like a worm.

The cycle in mosquito is completed in 10 to 14 days in warm and moist climate and in about 6 weeks in cold climate. humidity above 70 percent and temperature between 21 and 30 percent favor larval development in the mosquito. Temperature below 15 percent or above 33 percent is unfavorable.

Occurrence

It is estimated that globally 751 million population is exposed to the risk of filariasis. Half of these are in India. 78 million persons worldwide have filarial infection. 92 percent of the infections are due to *Wuchereria bancrofti*. The remaining have *Brugia* infection. Estimates of prevalence in 1962, 1970, 1976 and 1981 have shown that problem is increasing in India.⁷ Recent estimates indicate that 374 million people are exposed to the risk of infection. 251.8 million of these live in rural areas and the rest in urban areas. Nearly 43.8 million are infected with *W. bancrofti* and 4.8 million with *Brugia*. The number of diseased persons is estimated to be 17.6 million.³ The incidence of infection and disease is currently unknown except for a study in rural areas of East. Godavari district in AP where it was seen that the six monthly incidence of infection varied from 3.1 to 4.9 percent while the incidence rate of disease varied from 1.1 to 1.9 percent. The chronic disease incidence rate was 0.2 to 0.6 percent.⁹ Some idea about the prevalence can be had from the fact that in 1995, 37.3 lakh persons were examined and their blood slides collected. Microfilaraemia rate (% of slides positive) in them was found to be 1.1 percent while disease rate was 0.92 percent.^{9a}

In the past 3 decades, bancroftian filariasis has spread to new areas and the intensity of infection has increased. The major reasons for this phenomenal increase are:

- Extension of delimitation filaria surveys to hitherto unsurveyed districts.
- Natural growth of the population in endemic areas.
- Migration of large population groups to unaffected areas in search of employment.

- Establishment of transmission potential in new areas.
- Large scale developmental and construction activity in urban areas providing breeding grounds to the vectors.

Field studies undertaken reveal that bancroftian filariasis spreads centrifugally from urban to rural area. Present estimates indicate that bancroftian filariasis is endemic in 13 States and 5 Union Territories. Non-endemic areas include J and K, HP, Punjab, Haryana, Rajasthan, Delhi and Chandigarh in the North and Nagaland, Manipur, Tripura, Arunachal Pradesh, Mizoram and Sikkim in the East.⁷

The highest disease rate is seen in Uttar Pradesh followed by Bihar, Kerala, Orissa, Andhra Pradesh and Tamil Nadu. Uttar Pradesh and Bihar together account for two-thirds of the total cases seen in India.

Endemicity figures reveal that the Northern districts of Kerala, Tamil Nadu, AP, coastal districts of Orissa, eastern region of UP and small pockets in Maharashtra, Karnataka, HP, Bihar, West Bengal and Assam have microfilaria rates above 6 percent.

Presently 7.5 million people are exposed to the risk of *B. malayi* infection and there are 4.8 million microfilaria carriers and 1.25 lakh cases of chronic manifestations concentrated in a few rural pockets in Kerala, Andhra Pradesh, Orissa and West Bengal.

The diurnally subperiodic *W. bancrofti* similar to the form found in South Pacific Island, was discovered among the aboriginal population of Nicobar Islands. 22 million population is at risk while 100,000 are known to be infected.³

Assessment of prevalence is made by epidemiological and entomological surveys as in case of malaria.

Epidemiological Surveys

Blood surveys

- **Microfilaria rate:** It means finding the number of persons with microfilariae in peripheral blood per 100 tested. The population examined is 5 to 7 percent in case of routine survey and at least 20 percent in evaluation surveys as per standard practice at the NICD (National Institute of Communicable Diseases). 1 to 5 percent, 6 to 20 percent, 21 to 30 percent and over 30 percent microfilariae rates are indicative of low, moderate, high and hyper-endemicity respectively. The rate varies from 0.02 percent in Durg to 34 percent in Surat district. Two methods are in use. In the *thick drop method*, roughly 20 cumm (4 drops) blood from a finger is taken after 9.00 pm on a slide and a thick smear is prepared and dried. Next morning, the smear is dehemoglobinized with distilled water, fixed with methyl alcohol and stained with

methylene blue for half a minute. In the *concentration method*, 1 to 2 ml of intravenous blood is drawn after 9.00 pm in an oxalate bottle. Next morning, 1 ml blood is diluted with 5 ml distilled water and centrifuged at 2000 rpm for 8 minutes. A thick smear is prepared from the sediment and fixed by passing over the flame. It is dehemoglobinized with distilled water and fixed with methyl alcohol. Methylene blue is used in preference to Leishman stain because of its quicker staining property. A comparative study of the two methods found the microfilaria rate to be the same in both. A concentration technique involving filtration of blood has been found to be more sensitive.

- **Microfilaria density:** It is the number of microfilariae per unit volume of blood (20 cumm). It indicates the intensity of infection in an individual.
- **Average infection rate:** It is the average number of microfilariae per slide in a community, each slide being made from 20 cumm blood.

Clinical surveys: These are undertaken to find the disease rate, defined as the number of persons showing symptoms of filariasis per 100 examined.

Other methods: These include the immunological tests (skin test and serological test) described earlier. Their wide spread use can be possible only after these tests have been further refined.

Entomological Surveys

- **Vector density:** Expressed as *Culex fatigans* catch per 10 man hours.
- **Infection rate in mosquitoes:** Percentage of vector having any stage of the growing larva.
- **Infectivity rate:** Percentage of mosquitoes having the infective or third-stage larva.
- **Density of infection in mosquito:** Average number of growing larvae per mosquito.

Epidemiological Patterns

Four epidemiological patterns have been described:

1. High rates and densities of microfilaremia and few clinical signs of disease—Indication of stable transmission in high endemicity area.
2. High rates and densities of microfilaremia with many clinical signs of disease—Indication of either recent importation or increased transmission.
3. Low rates and densities of microfilaremia and many clinical signs of disease—Indication of either emigration of young people with microfilaraemia or decrease in transmission.
4. Low rates and densities for microfilaremia and few clinical signs of disease—Indication of stable transmission in an area of low endemicity.

Reservoir

The main reservoir is man, who harbours microfilariae in the blood. There is evidence that cats and nonhuman primates may act as reservoirs for subperiodic *B. malayi* in Malaya, Borneo and, probably, Sumatra.⁵

MODE OF TRANSMISSION

Filariasis is transmitted by mosquito. This can occur through certain species of *Anopheles*, *Culex*, *Aedes* and *Mansonia*. However, the main vector of *W. bancrofti* is *Culex quinquefasciatus*, while *B. Malayi* is mainly spread by *Mansonia annulifera* and *M. uniformis*. The female mosquito, which is an intermediate host, sucks micro-filariae along with the blood while feeding on human carriers. The microfilaria develops into infective larva in the body of the mosquito. On the next bite of a healthy person, the mosquito deposits the infective larvae on the skin. Some humidity and moisture are required for penetration. A large number die on dry skin or are killed on rubbing. Some may be resisted by lymphocytes also. Repeated infection is hence necessary for successful parasitism. On entry into the new host, the larvae lodge in the lymphatics and grow into adults.

Transmission of filariasis is remarkably inefficient. In an endemic area, about 100,000 mosquito bites annually are required to produce one new case of microfilaremia. In other words, the annual number of fresh, microfilaremia cases in a community can be estimated by dividing the expected number of mosquito bites by one lakh.¹⁰ The number of infective larvae per mosquito is usually small—fewer than five. It is probable that an infected mosquito transmits the disease to not more than one person. Transmission has been shown to occur when the average number of infective larvae received per person per year was more than 1000.¹⁰

Vector Characteristics

Culex quinquefasciatus is the vector of nocturnally periodic bancroftian filariasis in all parts of the country in 99.3 percent cases. Though no natural vector has so far been incriminated for the diurnal bancroftian infection in Nicobar, a species of *Aedes* group of mosquitoes have been found to be highly susceptible—*Aedes (Finlaya) niveus* group.

Mansonia annulifera is the principal vector of *Brugian filariasis* while *M. uniformis* is the secondary vector. The *Mansonia* require water plants like *Pistia*, *Eichornia*, etc. for their development.

INCUBATION PERIOD

The duration of the clinical incubation period (from invasion of infective larvae to development of chronic manifestation) is variable. The shortest period for esta-

blishment of microfilaremia is 4 weeks. However, usually it is 8 to 16 months. Allergic manifestation may appear three months after infection. Incubation period may be longer in indigenous inhabitants of endemic areas.

The infective larvae after entering the skin undergo two moultings in the human host. It may take 9 to 12 months for its passage from the skin to the lymph nodes where they finally lodge permanently. During their sojourn in the body they can give rise to allergic manifestations like bronchitis, eosinophilia and related symptoms. The incidence of Tropical Pulmonary Eosinophilia (TPE), which is thought to be related to microfilaria, was determined in a rural area in AP. The incidence was very low (1 per 100,000 population per annum) though microfilaria rate was above 15 percent.

PERIOD OF COMMUNICABILITY

Filariasis is not transmitted from person to person. Man is infective for mosquitoes as long as microfilariae are present in blood, which may be up to 5 years or longer after initial infection. The mosquito becomes infective about 10 days after the blood meal.

SUSCEPTIBILITY AND RESISTANCE

The disease rarely occurs in the casual or short stay visitors to endemic zones. Prolonged stay and repeated exposure is needed for infection. The authors found no infection in persons who stayed in Jamnagar, an endemic zone, for less than 18 months. In a survey carried out there in 1960, the microfilaria rate was found to be as given follow:

Stay (months)	No examined	% infected
0-17.9	125	0
18-23.9	161	1.9
24-35.9	91	8.8
above 36	157	17.2

The prevalence of microfilaremia usually increased with age. In some regions prevalence plateaus in early adult life while in others it rises steadily with age. There is also a consistent increase in the disease rate with increasing age. Infection at earlier age is reported more commonly with *B. malayi*, perhaps due to the shorter incubation period. However, microfilaremia below one year of age has been reported in both infections.³ the earliest age at which disease manifestations have been reported is one and two years with *B. malayi* and *W. bancrofti* respectively.¹¹

Since the biting rate remains constant for all ages, and a plateau is seen in adult age, this implies that after the age of 20 years immune mechanism are effective against the acquisition of new infection. The immunity probably functions against the infective stage rather than against the adult worms or microfilariae.¹²

It has been observed that in areas where genital manifestations predominate, males invariably show higher disease rates than females while the reverse holds true for areas with predominant extremity lesions.

METHODS OF CONTROL

These may be discussed with reference to the host (man), the agent (microfilaria) and the environment (vector).

Measures for the Host

These relate to personal protection against mosquito bite and are similar to those outlined under malaria prevention.

Measures against the Agent

These relate to the use of antifilarial drugs. Two antiparasitic drugs are available for chemotherapy: Diethylcarbamazine (DEC) and Ivermectin.

Diethylcarbamazine (DEC) has been the conventional therapeutic mode employed. DEC has significant microfilaricidal but only limited macrofilaricidal activity. It reduces filarial transmission as it reduces the number of circulating microfilariae. Administration of DEC reduces prevalence and intensity of microfilaremia.

DEC has been used both for individual treatment and for mass treatment of populations.

- *Individual treatment:* DEC given in a daily dose of 5 mg/kg for 10 days rapidly reduces Mf density within a few days but the effect is not sustained. When a total dose of 72 mg/kg is given over an extended period, the decrease in Mf density is much slower but eventually reaches the same level as with 10 day regimens and the effect lingers on for a longer period. Alternatively, an intense 5 to 7 day short course can be given for rapid reduction in the number of microfilariae and this can be followed up smaller doses given at wider intervals for achieving a persistent reduction in prevalence and intensity of microfilaremia. Various doses that have been used include 6 mg/kg for 12 days and 9 mg/kg for 4, 6, 8, or 12 days.

Toxic reactions to DEC are frequent, occurring in 25 to 100 percent of medication acceptors. These reactions are more common during the first few days of treatment and are more frequent in patients with high Mf counts. The reactions are thought to be due to rapid destruction of Mf and liberation of toxins from killed Mf. The adverse reactions are endured by sick people but discourage the normal or asymptomatic persons and populations from drug compliance.

The effectiveness of DEC may be assessed by change in the number of Mf in humans, number of

infective larvae in mosquitoes and alterations in the frequency and severity of clinical manifestations of filariasis. Mf counts come down by 80 percent while mean density of circulating Mf decreases through more than 90 percent.

- *Mass treatment:* DEC has been used for mass treatment in China, Japan, Brazil, Tanzania and India. The reasons for undertaking mass treatment are:
 - If all members in a specified population are not treated, it would necessitate night blood examination of every member of the community. This is a daunting task.
 - A single blood examination may not reveal infected persons if concentration techniques are not used.
 - Carriers of Mf are often asymptomatic and are unlikely to come for blood examination.

Common salt medicated with DEC in 0.2 to 0.4 percent concentration for six months has been successfully tried for mass treatment.⁵ DEC citrate has been found to be quite stable and can withstand prolonged heating. However, the long-term impact of large scale programs has been limited.

DEC only has a limited impact on established disease. It is only partially effective against adult worms. It is excreted in urine as well as stools and is a strong vermifuge for roundworms. Rarely, untoward effects may be seen after DEC administration. They occur due to sudden killing of microfilariae in large numbers. These include fever, urticaria, bullae formation, swelling of joints and in some cases, orchitis. Other side effects such as nausea, vomiting, headache, drowsiness and anemia may also occur.

Ivermectin

This semisynthetic agent has recently emerged as the drug of choice in treatment of onchocerciasis. It has been tried in bancroftian filariasis but not found to be very useful.

Measures Against the Vector

- *Antilarval measures:* Larvae are the preferred target for *Culex quinquefasciatus*. In addition to petroleum oils, organophosphate insecticides like temephos, malathion, chlorvinphos, chlorpyrifos and diazinon are very useful in low concentrations. They remain effective for several weeks in polluted stagnant water so that frequent treatment is not necessary. For petroleum oils like MLO (Malarial Larvicidal Oil) or kerosene, 15 ml/m² at 7 to 10 day intervals is required. The application of organic oils to the water surface is effective in suffocating the culex larvae which breathe air through the water surface. However, since these oils are biodegradable, they need repeated application.

Recently polystyrene beads have been effectively utilized in the form of floating layers. Being non-biodegradable, they have permanent action. They are particularly useful for control of breeding in stagnant water confined within walls. They have been found to be in place even three years after application to cess pits.³

- **Anti-adult measures:** Chemical control with organochlorine agents like DDT, BHC, etc. is no longer effective due to vector resistance. Organophosphates like malathion are still effective.
- **Environmental control:** It is aimed at eliminating vector breeding sites in the following ways: (a) Construction of soakage pits for villages; (b) Properly constructed surface drainage for small towns; (c) Constructing closed underground drainage in big towns; (d) Destruction of aquatic plants.
- **Biological and genetic methods:** These may be available for large scale control in future. *Bacillus sphaericus*, a spore forming organism, is toxic to culex species more than other mosquito species. It has the potential to persist and recycle under field conditions, especially in polluted waters. The method has been effectively used for *Mansonia* species also. A briquette formulation of *B. sphaericus* was used in ponds in Kerala. This reduced the larval population considerably at a dose of 15 to 30 kg of active ingredient per hectare.³

Criteria for Control

The WHO has fixed the following two criteria as indicators of adequate control:

1. Mf rate should be less than 5 percent in a community
2. Children aged 1 to 10 years should be free from microfilaria infection.¹⁰

National Filaria Control Program (NFCP)

The National Program was launched in 1955.

ORGANIZATIONAL ASPECTS

Central Level

In 1978, NFCP was bifurcated into two components:

- **Research and training component** under overall change of a Deputy Director at NICD and conducted at 3 Regional Filaria Training and Research Centers located at Kozhikode, Rajahmundry and Varanasi, each headed by an Assistant Director.
- **Operational component** under Director, NMEP, to look after planning, coordination and evaluation activities.

State Level

- **Headquarter Bureaus** established at AP, Bihar, Gujarat, Kerala, MP, Maharashtra, Orissa, Karnataka, Tamil Nadu, UP, West Bengal and Goa exclusively for coordination and supervision.
- **Survey Units** for correct appraisal of the extent and collection of epidemiological data.
- **Control Units** established with the objective of evaluating known methods of filaria control and evolving suitable strategies. Each unit covers 3 lakh population mainly in the urban areas. Recurrent larvicidal activities are the major component.
- **Filaria Clinics** established at the rate of one clinic for 50,000 population to reduce reservoir of infection through antiparasitic measures. Work involves collection of night blood samples by home visiting 75 persons every night for 20 nights in a month. Each unit is expected to cover the allotted population in 2 to 2.5 years. Filaria cases and those having microfilaremia are treated with 72 mg/kg DEC.

Financial Allocation

At present the operational cost is borne by the states while the cost of equipment and materials is shared on a 50:50 basis by the center and state.

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Arboviruses

The arboviruses (arthropod-borne viruses) are defined¹ as "those viruses that are maintained in nature principally or, to an important extent, through biological transmission

between susceptible vertebrate hosts by hematophagous arthropods.” They are a group of taxonomically diverse animal viruses which are unified by an important epidemiologic concept—transmission between vertebrate host organisms by hematophagous (blood feeding) arthropod vectors, i.e. mosquitoes, ticks, etc. More than 100 arboviruses are now known to produce disease in man³ and half of these are found in India. It may be mentioned, however, that only two such diseases, dengue and sandfly fever, were believed to be present in India in 1951. By 1975, forty such diseases had been recognized in India and South East Asia. In addition, there are many more arboviruses that occur in nature but do not cause disease in man. The arboviruses are divided into six major groups and many smaller groups. The major groups are Togaviruses (alphaviruses) or group A arboviruses, Flaviviruses, Bunyaviruses, Rheoviruses (Orbiviruses), Rhabdoviruses and Orthomyxoviruses. Of these, the Alphaviruses and Flaviviruses are the best known. These two genera include agents causing encephalitis and certain febrile illnesses. Alphaviruses are mosquito-borne. Flavivirus group includes agents that are borne by mosquitoes, ticks or certain unrecognized vectors. The epidemiological features related to transmission cycle of diseases caused by arboviruses are closely related to the type of vector concerned. Hence the diseases under a clinical syndrome caused by arboviruses are usually classified into four groups as follows:

1. Mosquito and midge-borne
2. Tick-borne
3. Sandfly-borne
4. Unknown.³

The present trend is to name the viruses after the place where they are discovered. Among the vectors for arboviruses, the most common are mosquitoes, others being ticks, sandfly, etc. *Four major disease syndromes* are produced by arboviruses:

1. An acute central nervous disease, often in the nature of encephalitis, e.g. Japanese encephalitis.
2. Acute benign fever of short duration, e.g. dengue
3. Hemorrhagic fever, e.g. hemorrhagic dengue, yellow fever and chikungunya fever.
4. Fever with polyarthritis and rash.

In terms of the total number of cases, these diseases are much less prevalent than diseases like measles and malaria. However, their public health importance lies in their epidemic potential, difficult treatment and high case fatality.²

Yellow Fever (ICD-A95.9)

Yellow fever is not found in India, yet it is of utmost importance to be vigilant against its entry. Once the yellow fever virus gets imported, the disease may spread rapidly because *Aedes*, the vector, already exists in

India. Hence the necessity to know the relevant details about yellow fever.

Identification

Yellow fever is primarily an infection of monkeys and is an accidental zoonosis in man. Subclinical infections in man are very common. Among the clinical cases, four grades of severity are seen:

1. *Very mild*: Patients experience only transient fever and headache, persisting usually for a few hours.
2. *Mild*: Fever and headache are more pronounced and may be accompanied by nausea and epistaxis. Epigastric pain, backache, generalized bodyaches, vertigo, vomiting and photophobia may be seen sometimes. This usually lasts for 2 to 3 days.
3. *Moderately severe*: It is characterized by high fever with severe headache and backache, intense nausea and vomiting. The course of the illness is usually diphasic. In the second phase, jaundice, black vomitus, melena and other bleeding disorders may be seen. The fever generally persists for a week.
4. *Malignant*: All the classical signs and symptoms are present. Hepatic and renal involvement is present and fever and hemorrhagic manifestations are clearly noticed. Death generally occurs between 6th to 8th day of illness. The overall mortality is 40 to 50 percent.

It may be mentioned that overall case fatality rate in yellow fever in endemic regions is 5 percent in indigenous populations.³

Laboratory Findings

Urine shows hematuria and albuminuria. Leucopenia is common, most marked on the fifth day. The three planks of diagnosis are serological investigations, virus isolation and histopathology. The virus can be isolated from the blood by inoculation into suckling mice, mosquitoes or tissue culture.³ Demonstration of rising titre in paired sera (in acute and convalescent phases) is diagnostic, though serological cross reactions may occur with related viruses. It must be remembered that liver biopsy is contraindicated due to the risk of bleeding. Typical histopathological lesions in liver are suggestive of diagnosis but do not prove it.

INFECTIOUS AGENT

Yellow fever is caused by *Flavivirus fibricius*, a group B. Togavirus, which is 17 to 28 millimicrons in size. It is pantropic in nature. Passage through mice causes it to lose its viscerotropic character, while the neurotropic character remains. The latter too is lost on further passage through monkey.

Occurrence

It is present in 30 African countries lying between 15°N to 10°S and 10 American countries lying between 10°N to 40°S.⁴ It is prevalent in endemic form in Mexico, Central and South America, East, West and Central Africa and West Indies. No outbreak of urban yellow fever transmitted by *Aedes aegypti* (man to man transmission) has occurred in Americas since 1942, except for a few cases in Trinidad in 1954.³ Such outbreaks still occur in Africa, the latest having taken place in Gambia in 1979 to 80. Sporadic outbreaks of sylvan or jungle yellow fever have occurred from time to time in Central South America and Africa. There is no evidence that yellow fever has ever been present in Asia.

Yellow Fever in India

Yellow fever has not been reported in India so far though, with the greatly increased international travel, the virus must have at times entered India particularly from the east coast of Africa, with which India has a lot of trade. *Aedes aegypti* mosquitoes and *Macacus rhesus* (North India monkey) and *M. sinicus* (South Indian monkey) are all found herein abundance. There are two views advanced to explain the absence of yellow fever in India.

1. Cross immunity with other widely prevalent flavo-virus infections (KFD, Dengue, Japanese encephalitis) may protect against yellow fever. However, there is evidence that Nigerians having flavovirus antibodies also developed yellow fever.
2. Repeated mosquito bites by *A. aegypti* may stimulate antibody production against the mosquito which, somehow, may also protect against the yellow fever virus.

Reservoir

For the jungle type yellow fever, the reservoir are monkey, possibly also marsupials and forest mosquitoes. In the urban type, man and *Aedes aegypti* mosquitoes act as reservoir of infection. It is possible that transovarial transmission may enable the infection to be perpetuated in the mosquitoes.³

MODE OF TRANSMISSION

Sylvan or jungle yellow fever occurs as a natural infection in monkey and is transmitted from monkey to monkey by mosquitoes living in tree tops (*Aedes africanus* in Africa and *Hemagogus* species in America). *H. janthinomys* is the primary vector in America. This day biting mosquito lives on tree tops and follows people up to 300 m outside the forest. When trees are felled or when monkeys raid human populations, the infection

is transmitted from monkeys to man by *Aedes simpsoni*, which breeds in the axils of banana plants. Thus while *A. simpsoni* is responsible for transmission from monkey to man and *A. aegypti* from man to man, there is good epidemiological evidence from Ethiopia that *A. simpsoni* may be responsible for person to person transmission also.³

In urban type of yellow fever transmitted by female *A. aegypti*, the mosquito becomes infectious in 10 to 12 days after bite and remains so for the whole life.

INCUBATION PERIOD

3 to 6 days.

PERIOD OF COMMUNICABILITY

Man is infective for mosquitoes shortly before onset of fever and for 3 to 5 days afterwards. The extrinsic incubation period in the mosquito is 9 to 12 days. The mosquitoes remain infective throughout life.

SUSCEPTIBILITY AND RESISTANCE

All ages and sexes are equally susceptible. Whites suffer more than the blacks. One attack gives lifelong immunity. Subclinical infections immunize the community living in endemic areas.

METHODS OF CONTROL

Eradication is difficult because of the jungle cycle, with forest rodents serving as a reservoir. The three points of attack to control yellow fever are:

1. Reducing vector population by vector control measures.
2. Protecting the susceptible host.
3. Reducing mosquito—man contact.

Reducing Vector Population

In endemic areas, antilarval and antiadult measures against the *Aedes* species are important. These measures have been described earlier. In areas free from yellow fever, such as India, entry of yellow fever from outside has to be prevented. All ports should be kept mosquito-free. The *Aedes aegypti* index should be maintained well below 1 percent.

Protecting the Susceptible Population

Immunization: People living in endemic zones and those leaving or arriving to such zones should be immunized with yellow fever vaccine which protects for at least 17 years, possibly much longer.³ The vaccine used is the 17 D vaccine or Rockefeller vaccine.⁵ It is a live attenuated vaccine prepared from the 17 D strain

cultured on chick embryo. It is freeze dried and should be stored at -20°C at central or regional stores and at 4 to 8°C at the periphery. The shelf life of the vaccine is 1 year from the date of manufacture. The vaccine is reconstituted with 0.5 ml normal saline and is administered subcutaneously. After reconstitution, the vaccine should be kept on ice and used within an hour. It should be protected from light.⁵ The risk of encephalitis associated with its use is minimal and it is now the only vaccine produced. It is preferable not to vaccinate children below nine months so as to prevent encephalitic sequelae, though, during epidemics, even four months old infants may be vaccinated. As maternal antibodies persist till 4 months, younger infants need no vaccine. The French neurotopic vaccine (Dakar vaccine), widely used earlier, is now no longer manufactured. It was a mouse brain vaccine associated with frequent reactions, including fatal encephalitis.

- Vaccine safety in pregnant women has not been confirmed yet; thus pregnant women should restrain her from going to endemic areas.
- **Safety of Yellow Fever Vaccine:**⁶ The GACVS considered the cases of fatal viscerotropic disease following yellow fever vaccination reported in some countries (United States, Brazil and Australia). The cases were attributable to a vaccine-type virus and not to a reversion of the vaccine strain to wild type. In contrast to the viscerotropic complications of yellow fever vaccination, recent neurotopic cases have not been fatal. The latter have been presumed to fall into one of 3 different clinical forms: Guillain-Barré syndrome (immune mediated), encephalopathy (owing to virus invasion), and acute demyelinating encephalomyelitis (caused either by direct virus invasion or by an immune-mediated response).
- **International Vaccination Certificate:** Yellow fever is now the only disease for which an International vaccination certificate is essential. All individuals coming out of an endemic area or passing through such areas should be carrying this certificate. The validity of the certificate begins on the 10th day after vaccination and is valid for 10 years. Revaccination before the end of 10 years revalidates the certificate for a further period of 10 years from the new date of vaccination. The revalidation is effective from the same day on which vaccine was administered. The vaccine is only available at selected places in the country. In Delhi it is available at the NDMC, Connaught Place and Palam Airport.

Quarantine: All unvaccinated persons coming from yellow fever areas are quarantined at the airport or seaport in mosquito-proof rooms for six days, counting the period from the time of their leaving the endemic area.⁶

Surveillance: In the endemic areas a constant watch on the yellow fever situation needs to be maintained

so that action can be instituted on receipt of any change in the situation. Surveillance can be undertaken in the following ways:

- **Clinical surveillance:** All probable cases of yellow fever should be identified and managed. For identification of yellow fever, the broadest possible clinical definition should be used. All febrile illness episodes with jaundice should be investigated. The diagnosed cases should be immediately notified to the next higher authority within 24 hours.
- **Serological surveillance:** In zones of emerging yellow fever problem, annual serological survey of children below 2 years of age may provide information on the recent circulation of yellow fever virus.
- **Vector surveillance:** Surveillance of the vector population helps to identify transmission potential and information on impending outbreaks.

Reducing Mosquito-man Contact

Use of mosquito nets and other personal prophylaxis methods will reduce contact with the vector. These have been described earlier.

International Aircraft Regulations, 1950:

- Areas where yellow fever exists or has existed during the past 13 years in any form recognized clinically or otherwise, should be designated as endemic areas.
- Aerodrome to be at least 0.5 km from habitation.
- Staff quarters to be mosquito-proof.
- Aerodrome to be mosquito-free up to a perimeter of 300 meters.
- Staff to be regularly protected by inoculation.
- Yellow fever inoculation certificate, not more than 10 years old, to be produced by persons lodging in the endemic zone.
- Inoculation of aerodrome staff where disease is likely to be imported.
- WHO requirement to disinfect aircraft: A low pressure freon aerosol dispenser or bomb containing 0.4 percent pyrethrin and 30 percent DDT should be used to release 10 g per 1000 cu ft (300 mg per cubic meter) at the rate of 1 g per second. The doors should be kept closed for at least 5 minutes after spray. The aircraft should be disinfected after luggage has been stored out before passengers embark.

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Dengue (ICD-A90)

Identification

A moderate to high fever, lasting 5 to 7 days, showing saddle shaped temperature curve with severe pains in limbs, backache, headache, retroorbital pain, bradycardia, leucopenia and measles like eruption on the third or fourth day. Nausea and anorexia are also common. The clinical features are related to the age of the patient. Infants and young children tend to have an undifferentiated febrile illness with a maculopapular rash.¹ Two severe manifestations of dengue are Dengue Haemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS). Since 1980, there has been a marked increase in global incidence of dengue as well as DHF and DSS. 95 percent dengue death occur in children below 15 years. DHF occurs mostly in South East Asia, including India and Western Pacific Region (Philippines), and is characterized by petechiae, ecchymoses, epistaxis, melena and, ultimately, acute circulatory failure. Fatality rate in DHF is 10 percent even in the treated cases. It is among the 10 leading causes of hospitalization and death in children in at least 8 tropical Asian countries.¹ The Cuban epidemic in 1977 was the first outbreak outside the traditional zone.¹

LABORATORY FINDINGS

Leukopenia is characteristic and liver function abnormalities are also noted in dengue fever. Thrombocytopenia, increased fibrinolysis and hemoconcentration are frequent findings in the hemorrhagic form of the disease. IgM and IgG antibody can be detected by ELISAs.

COMPLICATIONS

Pneumonia, hepatitis, bone marrow failure may be seen. More severe complications like renal impairment, gastrointestinal bleeding and altered sensorium may occur in hemorrhagic fever or shock syndrome.

INFECTIOUS AGENT

It is a group B arbovirus (dengue types 1, 2, 3, 4), first isolated in India in 1945 by Sabin. DEN-2 and DEN-3 have been consistently associated with shock syndrome. There is only partial cross protection.¹ Dengue Hemorrhagic Fever (DHF), first recognised in Manila in 1954, is probably a strain of the dengue

virus. For sake of clarification, it may be stated that the same virus (Dengue types 1, 2, 3, 4) causes two disease syndromes—classical dengue and DHF. In each epidemic, one particular serotype usually predominates.

Occurrence

It occurs universally through the tropics and subtropics. Kolkata in endemic form. From time to time, Chennai explosive epidemics also occur. DHF epidemics have been described in Kolkata (1963), Vishakhapatnam and Chennai (1964), Jabalpur (1966), Pondicherry (1968) and various places in North India (1988) and Delhi (1996). DHF is a major problem in Myanmar, Indonesia and Thailand.² Dengue occurs in India immediately after monsoon season.

Reservoir

Man together with the vector acts as reservoir also because the virus is transmitted transovarially. In South-East Asia and West Africa, the monkey-mosquito cycle acts as reservoir.³

MODE OF TRANSMISSION

A. aegypti, a domestic mosquito, is the common and most efficient vector. The females bite man during the day and, after feeding on an infected individual's blood, can transmit infection immediately by a change of host when the blood-meal is interrupted or after an incubation period of 8 to 10 days during which time the virus multiplies in the salivary glands. *A. albopictus*, *A. polynesiensis* and *A. scutellaris* are less efficient vectors. Transovarian transmission of virus has been demonstrated in the laboratory but its importance in disease transmission is not known. The disease has been experimentally transmitted to volunteers by bites of mosquitoes. Low density of 3 per 10 man hours catch is enough to carry on the epidemic.⁴ A study from Kolkata reveals that *Aedes albopictus* is competing with and replacing *Aedes aegypti*.⁵

INCUBATION PERIOD

3 to 14 days, commonly 5 to 7 days.

PERIOD OF COMMUNICABILITY

The blood of the patient contains dengue virus about 18 hours before the onset of fever and during first three days of the fever. The mosquito becomes infective after 11 to 14 days and remains so for the rest of life.

SUSCEPTIBILITY AND RESISTANCE

All ages and both sexes are susceptible, though DHF is more common in children. Demonstrable immunity results after artificially or naturally acquired infection, hence there are intervals between epidemics. The immunity is usually long lasting. There are no secondary cases. Repeat attacks within very short periods due to infection by a different serotype are well known. Rainy season is conducive to *Aedes* breeding due to water collection in earthen vessels, flower pots, coconut shells, etc. Hence the maximum incidence is seen from August to October.

METHODS OF CONTROL

The usual mosquito control measures aimed at preventing breeding, killing of larvae and adults and avoiding mosquito bites should be adopted. The patient should be kept within a mosquito net or screened room for the febrile days of illness during which he may be infective.³ This helps in preventing, the spread of infection. It may be mentioned that the mosquito vector tends to bite more during day time. Health education of people is of obvious importance. There is no specific treatment. Salicylates should be avoided for management of fever as they may cause bleeding and acidosis.¹ A dengue vaccine has been developed in Thailand with WHO assistance. Clinical trials are being conducted. Ringer's lactate (in shock it corrects acidosis), blood products and vasopressor agents are reserved for treatment purpose. Monitoring for hemoconcentration rather than platelet count helps in anticipating the complications of dengue hemorrhagic fever or shock syndrome.

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Chikungunya Fever (ICD-A92.0)

It is a hemorrhagic fever caused by a Togavirus. The clinical picture may be similar to dengue hemorrhagic fever except that pains are limited to joints. The vectors are *Aedes*, *Culex* and *Mansonia* mosquitoes. It was first isolated in Tanzania in 1952 to 53, where the local word chikungunya means doubling up (in pain and prostration). Epidemics occurred in Chennai and Kolkata in 1963 and 1965. No further outbreaks have been reported in India.

Japanese Encephalitis (ICD-A83.0)

Japanese encephalitis occurred in Japan as a severe epidemic in 1924. Epidemics occurred almost annually thereafter till 1970. Since then the disease has been steadily declining in Japan.

Identification

It is an acute inflammatory viral disease. The onset is rapid, encephalomyelitis developing fully within 2 to 4 days after onset of symptoms. Clinical diagnosis partly depends upon alertness on the part of the physician and his awareness of disease. The course of disease has three phases:

- Prodromal phase, before involvement of the nervous system.
- Acute encephalitic phase.
- Recovery phase, marked by complete or partial recovery of neurological deficit. The case fatality rate is 20 to 40 percent but may reach 58 percent or more.

Specific identification can be made by demonstrating specific IgM in serum on CSF in acute phase and by sequential rise in antibody titre.¹

STANDARD CASE DEFINITION²

Suspect (History)

A person of any age, at any time of the year with acute onset of fever and a change in mental status (including symptoms such as confusion, disorientation, coma or inability to talk) and/or new onset of seizures (excluding simple febrile seizures). Other early clinical findings may include an increase in irritability, somnolence or abnormal behavior greater than seen with usual febrile illness.

Probable (History and Clinical Examination)

A suspect case that occurs in close geographical and temporal relationship to a laboratory confirmed case of JE, in the context of an outbreak

Confirmed (Laboratory Tests)

Presence of JE virus specific IgM antibodies in a sample of serum and/or cerebrospinal fluid (CSF) as detected by an IgM-capture ELISA.

INFECTIOUS AGENT

Japanese encephalitis is caused by an RNA flavivirus belonging to the family *Togaviruses*. The Japanese encephalitis virus has a close antigenic relationship with west Nile and Dengue viruses.

Occurrence

Japanese encephalitis occurred in Japan as a severe epidemic in 1924, and epidemics occurred almost annually thereafter till 1970. Since then the disease has been steadily declining in Japan. At present it is prevalent in China, South Asia and South East Asia. In China, in conditions of high enzootic transmission. It is a disease of children, mainly up to five years age. In South East Asia, an area of intermittent transmission, children up to 15 years are vulnerable. In South Asia, where transmission is episodic, persons up to 50 years age acquire encephalitis.³ Cases in India have been reported from 1955 onward, mainly in the south. During seventies, outbreaks were reported in West Bengal, Bihar and Assam. Cases from Manipur and Goa were reported in 1982. Incidence is higher in monsoon season.

Japanese encephalitis virus has been isolated from the following mosquitoes in India: *Culex tritaeniorhynchus*, *C. bitaeniorhynchus*, *C. gelidus*, *C. vishnui*, *C. whimorei*, *C. pseudovishnui*, *C. epidesmus*, *An. barbirostris*, *An. hyreanus*, *An. subpictus* and *Mansonia annulifera*.⁴

The most important epidemic prone areas in the country are West Bengal, Karnataka, Kerala, Andhra Pradesh, Assam and Tamil Nadu.

Reservoir

Not known definitively. Possible reservoirs are birds, rodents and mosquito.¹

Transmission

JE is a zoonosis. The transmission is maintained in animals (mainly pigs and birds) in the nature and man is only occasionally infected. The bird cycle is maintained through bird—mosquito—bird transmission. The pig cycle is maintained through pig—mosquito-pig transmission. Transmission is also possible, through mosquito, from pigs to birds and vice versa. Man is infected only occasionally, such infection being a dead end one. Man to man infection has not been documented. In areas of high prevalence, 100 percent pigs have been found to be infected.⁴ In India, where pork eating population, and hence the pig population, is much less, cattle also act as amplifiers of infection, but are less efficient in this regard compared to pigs.⁴ Among birds, the infection has been found in pond herons, cattle egret and, possibly, poultry and ducks. None of the infected animals mentioned above develops any signs or symptoms. The only domestic animal known to manifest signs of encephalitis following JE infection is the horse.

The most important vector species responsible for transmission are *Culex tritaeniorhynchus* and *C. vishnui*. Rice fields are a predominant breeding place for these mosquitoes, which are zoophilic, feeding primarily on

animals rather than man. Combination of Cold Cloud Duration (CCD) and Normalized Difference Vegetation Index (NDVI) was suggested as the best predictors to forecast increase in Japanese encephalitis vector abundance.⁵ In the presence of zoonotic infection, the following factors govern the spill over of infection in man:

- Relative abundance of vectors
- Density and absolute number of infected mosquitoes
- Adequate man-mosquito contact
- Longevity of the vector.

There is a decreasing trend in disease incidence in China, Korea and Japan and an increasing trend in India and South East Asia. The possible reasons for the increasing trend are:

- Adoption of extensive paddy cultivation
- Establishment of large modern piggeries
- Climatic factors
- Possible role of amplifying hosts.

INCUBATION PERIOD

5 to 15 days, the extrinsic incubation period in vector mosquitoes is 9 to 12 days.¹

PERIOD OF COMMUNICABILITY

Virus is not demonstrable in man after onset of disease. Viremia in high titre or for long period seldom occurs in horse. Hence both man and horse, who develop the disease, are uncommon sources of mosquito infection. Once infected, the mosquito remains infective throughout life. Viremia in birds lasts 2 to 5 days.¹

METHODS OF CONTROL

Control measures are directed primarily against the mosquito vector. Use of ULV (ultra low volume) insecticides (malathion, fenitrothion) by aerial or ground fogging has been found to be particularly effective. The antimosquito measures in general have already been described. There is no specific treatment for Japanese encephalitis other than supportive treatment. Antibiotics are not effective against the JE virus.

Vaccines^{2,6}

The vaccines used for immunization against Japanese encephalitis (JE) are

- Mouse brain-derived inactivated vaccine that uses the Nakayama strain: Production has been stopped from 2007 and presently not used in India.
- PHK cell-cultured, live-attenuated vaccine (e.g. SA 14-14-2 vaccine): Presently used in India. This vaccine is administered subcutaneously as a single 0.5 ml dose in left upper arm at the age of 16 to 24 months with DPT/OPV booster. Following the campaigns all children are targeted in the age group of 1 to 15 years in the high risk districts, the vaccine

is integrated into the UIP of that district. If a child 16 to 24 months of age has been immunized with JE vaccine during an SIA, that baby should not receive the vaccine again, as part of routine immunization. However, if a child above 2 years (24 months) of age has not received the JE vaccine through either RI or SIA, the child is eligible to receive a dose of the JE vaccine till the age of 15 years. This JE vaccine is not recommended for routine use in adults.

Safety of live 14 to 14-2 Japanese encephalitis vaccine

Live JE vaccine interferes with measles vaccine response. However, GACVS concluded that the safety profile of live JE vaccine appears satisfactory and the vaccine could safely be administered with measles vaccine as of 9 months of age because the interference is only temporary.⁷

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Sandfly Fever (ICD-A93.1) (Pappataci Fever)

Identification

This nonfatal disease is clinically similar to dengue fever. However, the onset is abrupt and fever appears within a few hours. The fever is accompanied by headache, retroorbital pain, sweating, lumbar pain, photophobia, arthralgia and stiffness of the neck and back. Anorexia, nausea and vomiting are frequent. A particularly frequent symptom typical of sandfly fever is a congestion of the face and neck resembling erythema of sun exposure which sometimes causes the disease to be confused with sunstroke. Illness usually lasts for 3 to 4 days but relapses are common.

The disease usually presents in endemic form in tropical and subtropical regions. It is endemic in arid regions of Pakistan and the Middle East. It was reported from India for the first time in 1967 from Aurangabad (Maharashtra).

INFECTIOUS AGENT

It is caused by the sandfly group of viruses or phleboviruses, eight of which are known.¹ The sandfly (*Phlebotomus papatasi*) becomes infected within a week after biting a patient with the infection and remains infective throughout its lifespan of one month. The patient is infective at least 24 hours prior to and 24 hours after the onset of fever. The sandfly bites after sunset and at dawn and produces severe local itching.

INCUBATION PERIOD

4 to 7 days.

SUSCEPTIBILITY AND RESISTANCE

It is universal and immunity is long-lived, so second attack is not common.

METHODS OF CONTROL

There is no specific treatment. Antifly measures, such as insecticide spray and application of repellents like DMP to exposed parts, are helpful. Sandflies should be denied access to infected individuals by the use of very fine screening or mosquito nets (10 to 12 mesh/cm, aperture size not more than 0.85 mm).¹ Cracks and fissures in the walls serve as breeding places for sandflies and should be filled up.

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Leishmaniasis (ICD-B55.9)

Leishmaniasis is caused by a group of morphologically and antigenically similar parasites belonging to the genus *Leishmania*. They were originally rodent parasites, but have now adapted themselves to canines and man. There are 3 main clinical types of disease:¹

1. There may be a primary lesion of the skin to which the infection is limited—*Cutaneous leishmaniasis*.
2. In some areas the skin lesions may metastasize to lymph glands, other areas of the skin and mucocutaneous junctions—*espundia* or *mucocutaneous leishmaniasis*.
3. In other areas, the infection metastasises throughout the reticuloendothelial system of the body—*kala-azar* or *visceral leishmaniasis*.

The first two are localized while in third is a generalized form of leishmaniasis.

Visceral Leishmaniasis (Kala-azar or Black Fever)

IDENTIFICATION

It is characterized by very irregular chronic fever for 1 to 2 years, high mortality (may be sometimes even 90 percent) and other features such as marked enlargement of spleen, frequent hepatomegaly, anemia and emaciation. Often there is hyperpigmentation of the skin, hence the name kala-azar or black fever. For epidemiological purposes, clinical examination, a serological test (usually aldehyde test) and response to antimony treatment are used as diagnostic criteria in endemic areas.¹ Definitive diagnosis depends upon demonstration of intracellular amastigotes (Leishman-Donovan bodies) or, preferably, culture of the organism from biopsy or aspirated material from bone marrow, spleen, liver, lymph node or blood.²

DIAGNOSIS OF KALA-AZAR³

Clinical

A case of fever of more than 2 weeks duration not responding to antimalarials and antibiotics. Clinical laboratory findings may include anemia, progressive leucopenia thrombocytopenia and hypergammaglobulinemia

Laboratory

Serology tests: The most commonly used tests are Direct Agglutination Test (DAT), rk39 dipstick and ELISA. However, all these tests detect IgG antibodies that are relatively long lasting. Aldehyde Test is commonly used but it is a nonspecific test. IgM detecting tests are under development and not available for field use.

Parasite demonstration: In bone marrow/spleen/lymph node aspiration or in culture medium is the confirmatory diagnosis. Sensitivity varies with the organ selected for aspiration. Spleen aspiration is considered as gold standard, has the highest sensitivity and specificity.

POST KALA-AZAR DERMAL LEISHMANIASIS (PKDL)³

Post Kala-azar Dermal Leishmaniasis (PKDL) is a condition when *Leishmania donovani* invades skin cells, resides and develops there and manifests as dermal lesions. Some of the kala-azar cases manifest PKDL after a few years of treatment. Recently, it is believed that PKDL may appear without passing through visceral stage.

Types of Morphological Lesions of PKDL

- Early hypopigmented macules (like macular lesions of Lepromatous Leprosy) usually occur on face but can affect any part of the body.
- Later on diffuse nodular lesions on those macules may appear.
- Erythematous butterfly rash which may be aggravated by exposure to Sunlight; an early sign of PKDL.
- Erythematous papules and nodules which usually occur on face, especially the chin.

These lesions progress over many years and seldom heal spontaneously.

INFECTIOUS AGENT

The disease is caused by *Leishmania donovani*, a flagellate protozoan which shows flagella in culture, but not in human body. It is seen as a round parasite with two nuclei (an oval macronucleus and a rod shaped micronucleus) in the endothelial cells of liver and spleen and in bone marrow, lymph glands and large monocytes in blood. The parasite was discovered by Leishman in 1903; Donovan observed it at the same time in Chennai, hence the name.

OCCURRENCE

The disease is endemic in Sylhet valley of Assam, Bihar and lower Bengal and was called Burdwan fever in the early fifties of last century. From these states, it has infiltrated into the eastern districts of Uttar Pradesh. A large number of cases have occurred in Tamil Nadu also. Besides India, the disease is also found in other tropical and subtropical regions such as China, Brazil, Mediterranean islands, Algeria, Tunisia, Morocco and Tropical America.

Kala-azar, a dreaded disease in the past, became rare in India around 1955 to 60. This has been attributed¹ to the following factors:

- Reduction of parasite load in the community as a result of successful treatment.
- Reduction of vector population as a collateral benefit of DDT spray during National Malaria Eradication Programme.
- Increase in immune resistance of the community.

Cases of kala-azar started reappearing in north Bihar around 1971, reaching a maximum of 100,000 cases in 1977 with 4500 deaths. The factors responsible for such resurgence were:

- Availability of a nonimmune population born after the 1950's
- Non-familiarity of the newer generation of doctors with the disease
- Inadequate supply of drugs for treatment of kala-azar and, consequently, incomplete treatment of known cases.¹

Kala-azar now endemic in eastern States of India namely Bihar, Jharkhand, Uttar Pradesh and West Bengal. 48 districts are endemic; sporadic cases are also being reported from a few other districts and estimated 165.4 million population at risk in 4 states. Mostly poor socioeconomic groups of population primarily living in rural areas are affected.

HIV and Kala-azar Coinfection³

Visceral leishmaniasis (VL) has emerged as an opportunistic infection in HIV and other immunosuppressed patients. However, in India it is not yet a serious problem. All co-infected patients are not symptomatic. Diagnosis may be altered because symptoms may be of short duration; fever and splenomegaly may not be marked; *Leishmania* antibodies may be undetectable. However peripheral blood smears of buffycoat and blood culture may yield good results. Response to treatment is poor; drug side effects may be more and relapses may be common.

RESERVOIR

Man is the only known reservoir in India. Dogs and rodents act as reservoir hosts in the Mediterranean and in Brazil, where they cause infantile kala-azar in age group 1 to 4 years.

Mode of Transmission

Phlebotomus argentipes, a sandfly, is the vector in India. It becomes infected when it bites a patient with Leishman Donovan bodies in the blood and transmits the same to a healthy person at the next bite.

Incubation Period

1 to 4 months, varies up to 18 months; may be as short as 10 days.

Period of Communicability

As long as parasites persist in blood. Man may be infective for sandfly even after clinical recovery.

Susceptibility and Resistance

Susceptibility is general. Long lasting immunity develops to kala-azar after the first infection.

Methods of Control

These may be described in relation to the host, the vector and the parasite.

Measures to Protect the Host: Endemic zones should be demarcated and residence in infected homes and

localities should be avoided. New huts should be rebuilt at least 300 meters away from the area of infection. Repellents and mosquito nets should be used to prevent insect bites.

Measures against Sandflies: Regular monthly spray of insecticides to kill adult flies.

Breeding grounds such as damp and dark places, especially cracks and fissures in the floors and walls, should be eliminated.

Measures against the Parasite³: Treatment of kala-azar based upon effective chemotherapy. Drugs available in India are:

- (i) Sodium Stibogluconate, (ii) Pentamidine Isethionate, (iii) Amphotericin B, (iv) Liposomal Amphotericin B, (v) Miltefosine.

Drug Policy under Kala-azar Elimination Program as per recommendations of Expert committee (2000)–*(This drug policy is under review).*

First Line Drugs

Short-term

- *Areas with SSG sensitivity >90 percent:* SSG IM/IV 20 mg/kg/day × 30 days.
- *Areas with SSG sensitivity <90 percent:* Amphotericin B 1 mg/kg b.w. IV infusion daily or alternate day for 15 to 20 infusions. Dose can be increased in patients with incomplete response with 30 injections.

Long-term

- *Areas with high level of SSG resistance (>20%):* Miltefosine 100 mg daily × 4 weeks.
- *Areas with SSG sensitivity >80 percent:* SSG IM/IV 20 mg/kg/day × 30 days or Miltefosine 100 mg daily × 4 weeks.

Second Line Drugs

- *SSG Failures:* Amphotericin B 1 mg/kg b.w. IV infusion daily or alternate day for 15 to 20 infusions. Dose can be increased in patients with incomplete response with 30 injections.
- *SSG and Miltefosine Failures:* Liposomal Amphotericin B.

General rule for taking Miltefosine capsule

- Have to take strictly for 4 weeks
- Do not have capsule in empty stomach
- During treatment keep the treatment card of Miltefosine give from health center carefully
- Miltefosine is contraindicated in child below 2 years and pregnant mother
- If doses of Miltefosine are not completed, then relapse of kala-azar and even death also might occur.

Treatment of PKDL

- SSG in usual dosages for kala-azar could be given up to 120 days.
- Repeated 3 to 4 courses of Amphotericin B can be given in patients failing SSG treatment.

Local Leishmaniasis

DERMAL LEISHMANIASIS

It is found in South America as cutaneous nodules due to *Leishmania braziliensis* which may form ulcers. The transmitting agent is the sandfly. Glands and mucous membranes may also be involved sometimes (mucocutaneous leishmaniasis or espundia).

TROPICAL OR ORIENTAL SORE

It is a localized indolent sore or ulcer named after the place where it is found, such as Baghdad button, Lahore sore, and Delhi boil. It is an infective granuloma of skin and subcutaneous tissues caused by *L. tropica*, which resembles *L. braziliensis*, the causative agent of mucocutaneous leishmaniasis. The characteristic feature is a hard, dry type of papular lesions with chronic ulceration found on the skin of face, hands and other exposed parts. The parasite may be seen in scrapings from the lesion. The female sandfly becomes infective within 1 to 3 weeks and transmits the infection from the sore by biting a healthy person. Incubation period varies from a few days to months.

TREATMENT

The sore is infiltrated with 5 percent mepacrine at several points and is followed by application of 10 percent mapacrine ointment. It may be cauterised by carbon dioxide snow at weekly intervals. Use of sodium stibogluconate (sodium antimony gluconate) as in visceral leishmaniasis is also effective. Amphotericin may have to be used in espundia.

References

1. Manson Bahr and Apter. Manson's Tropical Diseases (18th edn). London: Balliere-Tindall, 1982.
2. Benenson AS. Control of Communicable Diseases Manual (16th edn). Washington: American Public Health Association, 1995.
3. National vector borne disease control program. Directorate general of health services. Ministry of health & family welfare. National Vector Borne Disease Control Programme, 22, Sharnath Marg, Delhi - 110054. Available from: <http://nvbdcp.gov.in/kala-azar.html>

Plague (ICD-A20.9)

Plague is a zoonotic infection primarily affecting the rodents. Epidemics of plague with high fatality used to

occur in the past. It was well under control but an outbreak occurred unexpectedly in several parts of India in late 1994. Hence continued strict vigilance is essential as the danger of limited outbreaks in unexpected places is increasing.¹ This is so because natural foci of infection are still maintained (such as in field rodents as sylvatic plague), fleas are becoming more and more resistant to insecticides and regular insecticide spray for malaria is being discontinued. The WHO Expert Committee on plague has defined *domestic plague* as "plague that is intimately associated with man has a definite potential for producing epidemics". It has defined *wild plague* as plague existing in nature, independent of human populations and their activities.¹

Identification

The disease in man is preceded by epizootic in rats, indicated by a history of ratfall. The classical presentation is bubonic plague. Other important forms are pneumonic and septicemic plague.² Both bubonic and pneumonic forms may progress to the septicemic form.

- *Bubonic plague*: The onset is sudden. The patient has mental dullness, ataxia, fever, redness of conjunctiva, rapid soft pulse, albuminuria and moderate leukocytosis. On the second or third day, a painful bubo appears which is femoral and inguinal in 70 percent, axillary in 20 percent and submaxillary and cervical in 10 percent cases. The bubo resolves or suppurates in the second week. Case fatality rate varies from 40 to 80 percent in untreated cases, usually around 50 percent.³ Death often occurs within 3 to 5 days.
- *Pneumonic plague*: It presents a clinical picture like lobar pneumonia, with blood tinged watery sputum which is full of plague bacilli. Death occurs in almost all untreated cases within 4 days. Airborne infected sputum particles, when inhaled, can cause primary pneumonic plague in contacts.
- *Septicemic plague*: There is marked toxemia, prostration and high fever. Fatality is almost 100 percent in untreated cases, death occurring within 2 to 3 days. Infection spreads to various parts of the body, including the meninges.

Diagnosis

A rapid presumptive diagnosis can be made by finding bipolar staining, ovoid, gram-negative organisms in sputum or in the material obtained from a bubo. Specificity of microscopic examination is increased by using fluorescent antibody for tagging. The best serological test is passive hemagglutination (PHA) using *Yersinia pestis* Fraction-1 antigen. Early rapid diagnosis in acute cases may be possible with a newly developed antigen-capture ELISA test.³ Diagnosis can be confirmed by culture of

the organism from bubos, blood sputum or spinal fluid and by four-fold rise or fall in antibody titer.

Infectious Agent

Yersinia pestis, previously known as *Pasteurella pestis*, isolated by Kitasto and Yersin in 1894, is a short, gram-negative, bipolar staining, rod like cocco-bacillus, with rounded ends and a thin capsule. It is readily cultured on ordinary media. Guinea pig and other laboratory animals are susceptible to it. The organism does not survive outside the human or rat body and is easily killed by heat. It can survive, and even multiply, in the soil layers of rat burrows for up to 11 months. The burrow infected by a dead rat may infect a healthy rat through soil contact.⁴

Occurrence

Plague has occurred allover the world. The third plague pandemic began in 1896. It persisted in India for many years causing about one million deaths per year, the maximum number of deaths occurring in 1907. The incidence was high from 1943 to 1950, but afterwards it almost disappeared. World incidence has markedly reduced to the extent that there were only 484 cases in 1980. The disease is endemic today in Western US, Central Asia, South America, South Africa, Burma, Vietnam and Indonesia.⁵ The 1994 epidemic in India accounted for as many as 336 laboratory positive cases and 56 deaths.⁶

The disease is now maintained in nature as wild rodent plague with endemic foci in Russia, South America, South Africa, Central Asia, India, Burma, Vietnam and Indonesia. Such foci have been reported in India in the adjoining districts of Kolar (Karnataka), Chittoor (AP) and Salem (TN).

Reservoir

Man acts as the source in case of pneumonic plague only. Domestic rat (*Rattus rattus*) is the normal reservoir of plague. An epizootic in domestic rats precedes human epidemic. *R. rattus* is actually an intermediate reservoir of plague. Natural reservoirs are *R. norvegicus* (port rat), and wild rodents such as *Tatera indica*, bandicoot and *gunomyskok*. They convey the infection to *Rattus rattus* which acts as liaison between man and wild rodents. Immunity develops gradually in the commensal rats. Persistence of plague in wild rodents (*Tatera indica*) has been found in Uttar Pradesh. It is moderately susceptible to plague and may be instrumental in carrying over the infection through non-plague seasons. Spread of infection is probably related to the migratory nature of wild rodents.²

MODE OF TRANSMISSION

The disease is transmitted to house rats from wild rodents such as mormots in Mongolia and Siberia, ground squirrels in California and field rodents such as bandicoot, *gunomyskok*, *Tatera indica* and *Rattus norvegicus* in India. From house rate the disease is transmitted to man by fleas which are not true vectors because the major part of the life cycle of the parasite is not passed in them. Fleas suck in the infected blood from the diseased rate and the bacilli grow in their mouth and stomach. When they next bite a healthy rat or human being, they again introduce those bacillin into the blood. Fleas ordinarily prefer rat blood. When rats start dying in large numbers, they leave the dead rats and attack human beings. *Xenopsylla cheopis*, *X. astia*, *X. braziliensis* and *Nosopsylla fasciatus* are the vector species in India which spread disease from rodents to man. *X. cheopis* is predominantly found on the commensal rats while *X. astia* is the principal wild rodent flea, other fleas being uncommon. *Pulex irritans* (human flea), is the only flea that can spread infection from man to man. It is not found much in India. Man to man transmission by flea is particularly important in the Andean region of South America.³ Other modes of infection to man include: (i) Bite or scratch from domestic cats carrying plague infected wild rodent fleas; (ii) Droplet spread in pneumonic plague; (iii) Direct contact from handling infected animals and laboratory infection.

Studies have shown that transfer of fleas to a healthy animal or placing the animal within the jumping range of fleas (about 4 cm above the floor) permits infection. After the ingestion of infected blood, *Y. pestis* multiplies in the stomach of the flea and is passed out in the faeces. Thus the flea serves as a multiplier of the bacillus. Sometimes the fleas become blocked—a condition in which the stomach and esophagus become obstructed by a pure culture of *Y. pestis*. When such a flea feeds, it regurgitates the bacterial culture and transmits the infection. Such blocked fleas die rapidly in a warm, dry atmosphere.

Blocked flea is an efficient transmitter of plague and partially blocked flea is more dangerous than completely blocked flea, because it live longer.

INCUBATION PERIOD

Usually 3 to 4 days but varies from 2 to 12 days.

PERIOD OF COMMUNICABILITY

Man usually gets infection from fleas which remain infective for a few months under suitable conditions.³ Sometimes infection may occur directly from man to man when there is pneumonic plague or when a person comes in contact with suppurating bubos.

SUSCEPTIBILITY AND RESISTANCE

Plague respects no age, sex, caste or social group. Incidence is a little higher in women because of their greater proximity to house rats.

METHODS OF CONTROL

These are as follows:

- **Notification:** Continuous surveillance of human and rat plague and its prompt notification is necessary.
- **Isolation:** Not necessary, except in pneumonic plague.
- **Quarantine:** Suspected contacts should be kept under which for 6 days. Ships or planes coming from plague affected areas are also quarantined till declared free.
- **Diagnosis:** All unusual ratfall should be suspect. Dead rats should be dissected for microscopic evidence of plague and smears from spleen, heart, liver and lungs should be examined for plague bacilli.
- **Treatment:** Give streptomycin, 1 g stat and 0.5 g four hourly, till the temperature remains normal for 3 to 4 days. It used to be the antibiotic of choice. Since it may lead to severe toxicity, tetracycline 4 to 6 g daily for first 48 hours is now preferred.⁴ Chloramphenicol is equally effective. When antibiotics are not available, sulphonamide such as sulfadiazine 2 g stat and 1 g four hourly may be given. For chemoprophylaxis, if required, an antibiotic, 1 g per day, or sulphadiazine, 2 to 3 g per day, may be given for 6 days.
- **Disinfection:** In cases of pneumonic plague, sputum should be received in sputum cups containing antiseptic lotion. Vector control or disinfestation, i.e., destruction of fleas, is the most important measure because it stops the transmission of infection. Other measures include:
 - Patient's clothes should be boiled. Mattresses and furniture should be cynogassed or put in hot sun. Fleas die quickly on exposure to the sun. Other articles in the house should also be disinfected.
 - The house should be sprayed with DDT.
 - Rat burrows should be insufflated with 10 percent DDT powder in the interepidemic period to destroy the fleas. Alternative insecticides may be used if fleas have become resistant to DDT.
- **Immunization:** Mass inoculation should be carried out with plague vaccine when an epidemic is threatened and not as a control measure during an epidemic.¹ The plague vaccine is a suspension of formalin killed virulent capsulated *Y. pestis*. It is preserved with 0.5 percent phenol. 3 ml Haffkine's vaccine may be given by subcutaneous injection to adults as a mass dose in an emergency. However, it is better to give two doses of 0.5 ml and 1 ml respectively 7 to 14 days apart. Children are given

proportionately less. Immunity develops in 5 to 7 days and lasts for 6 months. Local and general reaction may occur lasting a day or two. International certificate is valid for 6 months, starting from the 6th day after inoculation. The vaccine is stored in a cool dry place. Its potency lasts 2 years. A live attenuated vaccine is also available. It is said to be more effective, but is associated with more marked local and general reactions.

- **Health education:** People should be trained with the aim of explaining the mode of spread of disease and rat control measures.
- **International measures:** WHO is to be promptly kept informed of any outbreak. International Sanitary Regulations of WHO, 1957, specify the measures applicable to ships, aircrafts and land transport arriving from the plague affected areas. Rat proofing of ships has almost eliminated the risk of transmission of infected fleas and rats but freighting of containers remains a threat. It is difficult to inspect and treat the containers at any stage of transport.⁴

PLAGUE IN INDIA

An epidemic of pneumonic plague occurred India in 1994.³ The recurrence of plague was not unexpected as per the well known epidemiological principles. All the necessary ingredients were present,⁶ namely:

- Reservoir in the form of wild rats.
- Vector in the form of fleas.
- Nonimmune population.
- Natural foci of plague in endemic areas perpetuated in the form of wild rodent-flea-wild rodent cycle.
- Plague season lasts from September to May. The wild rodents undergo aestivation in hot summer and live in closed burrows with stored food.
- Occurrence of recent devastating earthquake in the concerned areas in Maharashtra. Such natural calamities displace the wild rodents, resulting in their contact with domestic rodents and transmission of plague to the latter through fleas. The transmission from domestic rats to humans is a matter of time only.

WAS IT PLAGUE?

Serious doubts were raised whether the 1994 epidemic was plague. Two main discrepancies were:

1. Only very few bubonic cases occurred, that too in Beed. Most cases were of pneumonic type. This is against the past experience that bubonic plague precedes and predominates in comparison to the pneumonic type.
2. Diagnosis was based only upon seropositivity. Plague bacilli have not so far been isolated or cultured from humans during the recent epidemic.

In view of the above, various researchers claimed⁷ that the epidemic was not caused by *Y. pestis* but rather by some other agent such as:

- *Pseudomonas pseudomallei* causing melioidosis.
- Hantavirus, causing hantavirus pulmonary disease.
- *Francisella tularensis*, causing tularemia.

The WHO team of experts who visited India during the epidemic concluded that the evidence was “supportive of plague but not confirmatory”. In order to settle the controversy, the Central Ministry of Health and Family Welfare appointed a Committee under the Chairmanship of Dr V Ramalingaswami to give its verdict. The committee gave its report in 1995, certifying that the epidemic was caused by plague.

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4. WHO. Plague. WHO Chronicle 1970;24:373.
5. Wong TW, Fung KP. Asia Pacific J Publ Hlth 1988;2:144-49.
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Kyasanur Forest Disease (ICD-A98.2)

KFD is a viral disease spread through ticks. Tick borne viral diseases may manifest as viral fever (e.g. those caused by Ganjam and Bhanja viruses in India) or as viral hemorrhagic fever, the examples of the latter being Central Asian hemorrhagic fever in Pakistan and KFD in India. KFD is caused by a virus that closely resembles the Omsk hemorrhagic fever found in Siberia.¹ It was first detected in Karnataka in 1957 in the Kyasanur state forest in Shimoga district, when a febrile disease was noticed in the surrounding villages after unusually heavy monkey mortality in the forest. The KFD virus is a Flavivirus belonging to Togaviruses group of arboviruses.

Clinical Features

There is high continuous fever for 5 to 12 days accompanied by myalgia, arthralgia, headache and prostration. The clinical picture is reminiscent of dengue. In some cases, hemorrhagic features may be present in the form of bleeding from nose, gums and intestines. Cervical and axillary nodes are often palpable. Blood pressure and pulse are usually low. Among neurological signs and symptoms, neck rigidity is common in early phase. Mental confusion and drowsiness may be found occasionally. Most patients recover completely but some

patients may become comatose and die. The convalescent phase is prolonged over a month. Case fatality rate is 5 to 10 percent.² Incubation period is 3 to 8 days.

Reservoir and Transmission

Man plays no part in transmission of disease in nature. He is only accidentally infected and represents a dead end in the chain of transmission. The infection occurs naturally among vertebrates such as monkeys, shrews, rats and carnivorous bats. It is transmitted through hard ticks belonging to genus *Hemophysalis*, especially *H. spinigera* and *H. turturis*.

Since its detection for the first time in 1957 in Shimoga district, six outbreaks of KFD have occurred so far, the last having occurred in 1983.⁴ It was caused by large scale felling of trees in a virgin forest in September 1982, with consequent migration of monkeys, along with their tick parasites, to neighboring forests. The disease then became manifest in villages near the new forests, the number of cases being 1000 with 90 deaths.² Serological surveys of men and animals in different parts of India suggest that the disease may be widespread in the country.³ However, clinical disease is limited to 4 districts in Karnataka. The number of cases reported in Karnataka was 2167 in 1983. In 1987 and 1988, annual incidence was only about 300.⁵

The maximum number of KFD cases occur from December to June, the dry months. This period corresponds to the high density of nymphal stage of the ticks and also to human activity in the forest.² The eggs laid by the female tick hatch into larvae which, after a blood meal (usually in rat, squirrel, porcupine etc.) moult and develop into nymphs. After another blood meal, the nymph moults into an adult. All stages in this life cycle, except the eggs, can become infected.

Control Measures

The following four control measures are being enforced in Karnataka:

1. **Surveillance:** The Karnataka government has set up a surveillance system whereby regular monitoring of all cases and deaths suspect as due to KFD is undertaken.
2. **Spraying operations:** Spraying of acaricides on forest tracks which are used by man is done regularly. 5 percent DDT, 0.5 percent Lindane, 0.25 to 0.48 percent Bendiocarb, 5 percent carbaryl, 0.5 percent Diazinon, and 2 percent Malathion are all effective acaricides.
3. **Personal prophylaxis:** Tick repellants like Diethyl-toluamide (DET), Permethin and Butopyronoxyl are available for personal prophylaxis.
4. **Vaccination:** Immunization with formalin killed and inactivated KFD vaccine prepared from chick

embryo fibroblasts is being undertaken. The vaccine is currently being manufactured at the Virus Diagnostic Laboratories at Shimoga (Karnataka).

NIV, Pune has recommended that prior to forest clearing, forest ticks and forest animals should be examined for KFD virus and serological evidence of KFD respectively to ensure the absence of KFD in the area.³

References

1. Benenson AS. *Control of Communicable Diseases in Manual* (16th edn). Washington: American Public Health Association, 1995.
2. WHO. *Techn Rep Ser 721*, 1985.
3. Anonymous. Forest clearance triggers epidemic of KFD. *Medical Times* (Published by Sandoz). Vol. XIII. No. 10, p. 1, 1983.
4. ICMR. *Kyasanur Forest Disease: 1957 to 64*. Pune: Virus Research Centre, 1964.
5. Health Info India: DGHS, 1989.

Epidemic Typhus (Louse borne Typhus) (ICD-A75.0)

This was also called camp fever or jail fever. It is a rickettsial infection transmitted by lice and may occur in epidemic or endemic form. Unlike this, some other rickettsial fevers transmitted through fleas, mites and ticks are primarily enzootic infections that become endemic only accidentally.

Identification

It is a febrile infection with acute onset. A rash appears on the fourth or fifth day of fever on axillary folds, around shoulders, chest and abdomen in the form of macules and papules. Hemorrhages may occur. Nervous irritability is common. Fever is continuous and often disappears rapidly on the fourteenth day or any time from 13-17 days. The disease may recrudescence years after the primary attack (Brill-Zinsser disease).

Laboratory diagnosis is made by:

- A complement fixation test with group specific antigen which becomes positive in the second week.
- Weil-Felix reaction using *Proteus OX-19* strain which becomes positive in titre of 1/160-1/320, but a rise in titre is of more value.

Occurrence

Spread is favored by cold and temperate climate, war, famine and overcrowding. It was a dreaded disease in the past and caused vast epidemics among soldiers and

refugees. Though it continues to be called epidemic typhus, it is no longer seen now in the form of epidemics. In endemic form, it is still found in some regions in Africa and South America.

INFECTIOUS AGENT

R. prowazekii.

Reservoir

Infected man.

MODE OF TRANSMISSION

The body louse or the head louse becomes infected 3 days after sucking the blood of a typhus patient. *Rickettsiae* grow in the gut of the louse and are passed in the faeces. Infection enters the skin when crushed louse or its faeces are rubbed over the skin, especially over a wound or scratch. Inhalation of louse faeces as dust may account for some infections. Infection may also gain entry through the conjunctiva.

INCUBATION PERIOD

5 to 23 days, average 10 days.

SUSCEPTIBILITY AND RESISTANCE

All ages and sexes are susceptible. Average fatality rate is 10 to 20 percent but is higher in middle age. One attack confers lasting immunity.

METHODS OF CONTROL

The basis for control of the disease is louse control and immunization.

- *Louse control*: If reporting is good, residual insecticides should be applied to all contacts. If infection is widespread, 10 percent DDT powder for delousing should be applied to all individuals.
- *Immunization*: Two types of vaccines are available.
 - Killed vaccine which reduces mortality to zero and brings down morbidity considerably. The vaccine is administered subcutaneously in 2 doses of 1.0 ml each at an interval of 10 to 14 days followed by a booster dose of 1.0 ml at the beginning or the middle of the typhus season.
 - Live vaccine prepared from the E strain of *R. prowazekii*. Reactions are commonly encountered.
- *Chemoprophylaxis*: A single dose of doxycycline to all members in a community will stop an epidemic immediately.

Laboratory personnel and medical staff should be immunized regularly.¹

Reference

1. Manson-Bahr and Apte. *Manson's Tropical Diseases* (18th edn), London: Balliere Tindall, 1982.

Trench Fever (ICD-A79.0)

It is also known as quintana fever or five-day fever. The fever lasts for 3 to 5 days and shows double rise. It may be of remittant or intermittent type. Sweating is common. Splenomegaly and leucocytosis are usually present. Complete recovery is the rule. Weil-Felix reaction may be helpful in diagnosis, but serological tests for diagnosis of trench fever are not in general use. Diagnosis can be confirmed by blood culture on blood agar under 5 percent carbon dioxide tension in air, when microcolonies develop after 2 weeks incubation at 37°C. Enzyme immunoassay tests are very sensitive and specific. Trench fever was commonly seen in the first and second world wars. It is rare at present. Endemic foci have been found in Poland, Russia, Mexico, Bolivia, Burundi, Ethiopia and North Africa. The causative agent is *R. quintana*. Man is the reservoir of infection. *R. quintana* live and multiply in the cuticular margin of the epithelium of the midgut of lice. Lice become infected by feeding on infected humans and remain infected for a year. It is not certain whether human infection is caused by the bite or by fecal contamination. The mode of spread is similar to epidemic typhus. The disease is found in all ages and sexes. Mortality is almost nil. Incubation period is 10 to 30 days.

Endemic Typhus (ICD-A75.2)

It is also known as murine typhus, urban typhus or flea-borne typhus. It manifests as a fever of slow or sudden onset. The face is often flushed. A rash appears on the fourth or fifth day. The fever lasts 7 to 14 days and ends by lysis. Fatality is below 1 percent.

Weil-Felix reaction with *Proteus* OX-19 is same as in a epidemic typhus. Complement fixation reaction with group specific typhus antigen becomes positive in the second week. Guinea pig inoculation gives a positive scrotal reaction called 'Neil-Mooser reaction'.

INFECTIOUS AGENT

Rickettsia typhi (*R. Mooseri*).

Occurrence

Worldwide in endemic form. It is especially endemic in certain areas in North America, Mexico, India, Pakistan, Queensland and Malaysia. Majority of cases occur in summer and autumn. The incidence is twice as high in males.

Reservoir

Rat, mice, squirrel.

MODE OF TRANSMISSION

A rat flea, *X. cheopis*, spreads infection from rat to man. The infection in the rat is non-fatal. It is transmitted from rat to rat by spinulosa, the rat louse. The most important factor in the occurrence of murine typhus is residence of human beings in areas where rats abound, such as grain stores.

INCUBATION PERIOD

8 to 14 days.

METHODS OF CONTROL

No vaccine is available. Insecticide applied to rat runs and burrows help in reducing the flea population.

Scrub Typhus (Tsutsugamushi fever) (ICD-A75.3)

It is also called mite typhus, rural typhus or hill typhus.

Identification

The bite of the infected larval stage of trombiculid mites produces an itch which develops into a local papule, vesicle, pustule or a necrotic lesion, called 'eschar', which heals within 4 weeks. Fever lasts 2 to 3 weeks. Generalised enlargement of lymph glands and maculopapular rash appear at the end of first week. Mild and ambulatory types are common. Weil-Felix reaction is often unreliable, being present in only 50 percent cases. Diagnosis is confirmed by inoculating patient blood into mice and isolating the organisms from the latter.

INFECTIOUS AGENT

R. tsutsugamushi, *R. orientalis* or *R. akamushi*.

Occurrence

The infection is prevalent in Japan, Formosa, Philippines, Hong Kong, China, Thailand, Burma, Malaysia, India, Sri Lanka, Pakistan and Maldives.

In India, indigenous pockets exist in Andaman and Nicobar islands, Tamil Nadu, Maharashtra, Punjab, Himachal Pradesh and Bihar.

The disease occurs in scrubby terrain, forests, and semi-desert conditions. It is more common in summer.

Reservoir

The infection is maintained by transovarian passage in mites.¹ Wild rodents also play a role through mite-rodent-mite cycle.

MODE OF TRANSMISSION

The larva of *Trombicula akamushi* mite (*T. deliensis* in India) may be already infected through transovarial transmission or may become infected after biting an infected animal. Man gets infected when infected mite larva attaches itself to man, sucks lymph and tissue fluids and introduces rickettsiae in the human host. The adult mite is non-parasitic and lives on vegetation. The disease is mainly restricted to adult workers who frequent jungle, hill and forest areas. Case fatality rate varies from 1 to 30 percent.

INCUBATION PERIOD

5 to 14 days. No effective vaccine is available for prevention

PROPHYLAXIS AND CONTROL

Control is based upon regulation of the environment and animate measures. Chemoprophylaxis with chloramphenicol and tetracycline can be used. No immunization is available.

Reference

1. Benenson AS. Control of Communicable Diseases Manual (16th edn). Washington: American Public Health Association., 1995.

Tick Typhus (ICD-A77.9) (Rocky Mountain Spotted Fever)

Identification

It manifests as fever lasting 2 to 3 weeks, accompanied by a maculo-papular rash, first appearing on wrists and ankles. Leucocytosis and albuminuria are often present. Gangrene of scrotum may sometimes occur. Death may occur in 3 to 4 days. Abortive and mild typhus also occurs.

Weil-Felix reaction is positive to OX-19, OX-2 and OXK antigens. Guinea pig inoculation results in fever and scrotal reaction.

INFECTIOUS AGENT

R. rickettsii.

Occurrence

It is found in USA, Canada, Mexico, Costa Rica, Panama, Colombia and Brazil. In India it is found in Kashmir and Assam.

Reservoir

Goats, horses, rodents, dogs and sheep.

MODE OF TRANSMISSION

Hard ticks such as *Dermacentor andersoni* (wood tick) and *D. variabilis*, infect the man through bites as well as excreta.

INCUBATION PERIOD

3 to 14 days.

SUSCEPTIBILITY AND RESISTANCE

There is general susceptibility. Case fatality rate varies from 5 to 40 percent and is more in higher age groups.

METHODS OF CONTROL

Control measures are based upon tick control, prevention of tick bites and immunization. Insecticidal sprays like DDT are effective in controlling Ticks. Tick bites may be prevented by avoiding notorious areas in spring and summer and wearing protective clothing.

Vaccines containing killed organisms have been used in high risk groups. However, no vaccine is commercially available. Efficacy is doubtful.

Two other tick borne rickettsial infections are African tick-typhus and Q fever, caused by *R. conorii* and *Coxiella burnetii* respectively. Q fever causes an influenza like disease and is recognized all over the world. African tick typhus is also known as Indian tick typhus as it is also found in India.

Relapsing Fever (ICD-A68.9)

Relapsing fever is of two types: Louse-borne and tick-borne.

Identification

In louse-borne relapsing fever, there are 2 to 3 bouts of fever lasting 5 to 6 days with remissions for 6 to 7 days. Fever comes down by lysis each time. Spleen and liver are enlarged and sometimes there is jaundice. In tick-borne relapsing fever and bouts of fever are shorter, lasting 3 to 4 days, and are irregular. Relapses may be greater in number. The aged and the infants may die. Diagnosis in both the types is made by finding spirochaetes in blood films during the febrile period. When spirochetemia cannot be demonstrated in this way, patient's blood may be inoculated intraperitoneally into young mice which develop spirochetemia within 14 days. Wassermann reaction is often false positive. Positive test may also be obtained with Proteus OXK, OX-19 and OX-2.

INFECTIOUS AGENT

Borrelia recurrentis, a spirochaete, in case of louse type and *Borrelia duttonii* and some other strains in the tick type.

Occurrence

The louse type has occurred in epidemic form in Europe, Asia and Africa, often in association with typhus. It was widespread in India earlier. Now it is found in Kashmir and hill districts of Assam and West Bengal. The tick type is found in Africa not in India. Louse-borne relapsing fever is usually more severe. It is estimated that during the first half of the present century, at least 50 million cases of louse-borne relapsing fever occurred in the world with 10 percent mortality. At present the major endemic focus of louse-borne relapsing fever is found in the highlands of Ethiopia, where there is an annual epidemic with at least 10,000 cases. The louse-borne form is mainly a disease afflicting poor populations living in squalor where the clothing (in which lice thrive) is worn continuously and where personal hygiene is poor. It is specially prevalent during famine, when people tend to crowd together and lice travel easily from one person to another.

Reservoir

Man in louse-borne type. Wild rodents and ticks (through transovarian infection) in case of the tick-borne type. The ticks belong to genus *Ornithodoros*.

MODE OF TRANSMISSION

Louse and soft tick, the vectors, become infective about 2 weeks after biting a patient and remain so for the whole life. The infective louse lives for one month more but the soft tick may live for five years in mud huts. The louse neither injects the infection by bite, nor passes

it in feces. When it is crushed and squeezed, the spirochetes enter through abrasions and possibly, the intact skin. The tick can transmit the infection while sucking blood since the organisms are present in its salivary glands. Because of transovarian infection, the tick acts as the reservoir of infection, which the louse does not.¹ The louse merely transmits the spirochete from man to man. The usual variety involved is *Pediculus humanus var. corporis*. However, *P. humanus var. capitis* can also transmit infection.

INCUBATION PERIOD

Louse-borne, 2 to 12 days; tick-borne, 5 to 10 days. Average, one week for both.

PERIOD OF COMMUNICABILITY

Throughout the febrile stage.

SUSCEPTIBILITY AND RESISTANCE

Susceptibility is universal. Immunity acquired after an attack is of low order. It may last upto 2 years and is specific for the species of *Borrelia*. There is no cross immunity.

METHODS OF CONTROL

Vector control against lice and ticks should be undertaken. The patients are treated with antibiotics such as penicillin and tetracyclines. Both effect cure within 3 to 4 days. Till April 1971, relapsing fever was an internationally quarantinable disease.

Reference

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Miscellaneous Zoonoses

Zoonosis is defined as an infection or infectious disease transmissible under natural conditions from vertebrate animals to humans.¹ A general introduction to zoonosis has been given in chapter 15. The following zoonotic diseases have already been described:

Bacterial: Brucellosis, colibacillosis (enteropathogenic *E. coli*), leptospirosis, mycobacteriosis (bovine and atypical mycobacteria), plague, relapsing fever, salmonellosis and vibriosis (*V. parahemolyticus*, *V. fetus*).

Viral: Kyasanur forest disease, dengue and Japanese B encephalitis.

Rickettsial: Endemic (murine) typhus, Indian tick typhus, scrub typhus and coxiellosis (Q fever).

Protozoal: Leishmaniasis, balantidiasis.

Helminthic: Echinococcosis, teniasis, hymenolepsis and fasciolopsias.

In this chapter are described only those zoonotic diseases which do not fit readily into the four major groups of communicable diseases (respiratory, water-borne, arthropod-borne and contact diseases) described earlier. These are rabies, rat bite fever, leptospirosis, anthrax, glanders and tetanus.

Rabies (ICD-A82.9)

The word 'Rabies' is a latin word, that has come from a Sanskrit word 'Rabhas' means – to do violence.

IDENTIFICATION

It is a viral disease characterized by acute inflammation of brain and spinal cord.

Rabies in Man Occurs in three Stages

1. *Prodromal stage:* Fever, severe headache, anxiety and restlessness for a day or two.
2. *Stage of invasion:* Restlessness increases. Hydrophobia, not found in animals, develops as a characteristic feature in man. When the patient wants to drink water, a sudden spasm of the muscles of mouth, pharynx and respiratory system develops, so much so that the patient is afraid of water itself. Change in voice, frothy saliva and anxious look, with a clear mind, are the other features.

3. *Stage of paralysis:* General paralysis, hemiplegia or paraplegia develop. Death occurs within 4 to 8 days.

Rabies in dog occur after an incubation period of 3 to 6 weeks, rarely more than a year. The disease in dog is of two types: furious and dumb rabies. *Furious rabies*, which accounts for 80 percent cases of canine rabies, occurs in 3 stages:

- The temperament and behavior of the dog is altered.
- The dog becomes restless with red eyes and hoarse bark. It runs amuck and becomes furious. Fury can be elicited by a stick which it bites and catches. There is profuse salivation.
- Paralysis develops later starting in the hind legs and becoming generalized. Gasping for breath occurs towards the later stages of illness and the animal dies within 10 days.

In dumb rabies, there is no excitation or fury but only paralysis followed by death. It constitutes 20 percent of the total rabies in dogs.²

Diagnosis

Rabies in animals and humans is still diagnosed on the basis of clinical signs and symptoms in many areas of the world. As a result, rabid dogs are sometimes considered to be uninfected while antirabies treatment is unnecessarily given to persons bitten by animals having other diseases, such as distemper.³ Quick, simple, cheap, reliable laboratory tests for diagnosis of rabies are not available. Laboratory tests available are mentioned below.³

- *Tests for postmortem diagnosis in animals and humans:* These are important for the following purposes: for management of persons exposed to animals (when the animal has died or been killed humanely); for confirmation of diagnosis; for reliable medical record and; for epidemiological purposes.
 - *Antigen detection:* This can be done by two methods. In the fluorescent antibody (FA) technique, which is a rapid, sensitive method, impression, smear or frozen section of brain tissue is examined microscopically under ultraviolet light. In the rapid rabies enzyme immunodiagnosis (RREID) method, enzyme-linked immunosorbent assay (ELISA) is used to detect rabies antigen in brain tissue. The test can

be carried out under field conditions since the antigen can be visualized with naked eye.

- *Virus isolation*: This helps in confirming the result of antigen tests as also in characterizing the virus.
- *Tests for diagnosis in patients*:
 - *Antigen detection*: This can be done during first few days by FA technique using corneal impressions or skin biopsy.
 - *Antibody detection*: Virus neutralizing antibodies appear in CSF and serum after 7 to 10 days of illness.
 - *Virus isolation*: From body fluids, especially saliva and CSF.

OCCURRENCE

As a disease of animals, rabies is found all over the world. Areas free of rabies in animal population at present include Japan, Hawaii, Taiwan, Australia, New Zealand, UK, Ireland and Sweden.¹ Only about 700 human deaths due to rabies are reported to WHO each year, but this is obviously due to gross under-reporting. Annual rabies deaths in India are estimated to be 25,000 to 50,000. Three to five million individuals are given postexposure prophylaxis every year.⁴

Roughly 36 percent of the world's rabies deaths occur in India each year, most of those when children come into contact with infected dogs.⁵ The islands of Andaman and Nicobar and Lakshadweep have been reported to be rabies free from time immemorial. The reason for this could be its geographical isolation from mainland. The wild reservoirs for rabies is absent as there are no foxes, jackals, wolves and bats on the islands. However, in Andamans the increasing dog population, poor vigil on import of dogs and lack of laboratory surveillance for rabies posed a threat to this situation. The Lakshadweep islands, which are free of dogs, face a threat from the lack of vigil on the entry and presence of cats and poor surveillance for rabies in them.⁶

Causative Agent

Rabies is caused by Lyssavirus type 1, a neurotropic virus belonging to the family Rhabdoviridae. The virus is seen as inclusion bodies called 'Negri bodies' in the hippocampus gyrus and cerebellum. These are round, oval or angular bodies, varying in diameter from 0.5 to 20 microns, appearing pink with Leishman's stain. The spikes projecting from the surface contain glycoproteins. The virus multiplies mostly in the nervous tissue and is distributed in the nervous system, saliva, urine, lymph, milk, etc. It is readily inactivated by sunlight, heat, disinfectants and ultraviolet rays. When the virus is freshly isolated from a case, it is called as *street virus* which requires 12 to 25 days to produce rabies in rabbits. By successive passage through a large series of rabbits, the virus can be made a *fixed virus*

capable of causing infection in 5 to 6 days. The fixed virus does not produce Negri bodies, cannot invade from the periphery and cannot multiply in the salivary glands. This attribute is taken advantage of in the preparation of vaccine against rabies.

RESERVOIR

The virus is found in the salivary glands and central nervous system of dogs and other rabid animals. It is excreted in saliva and urine. Dog is the major reservoir for the majority of cases of human rabies. However, more than 35 species of warm blooded animals, specially the canines, are susceptible to rabies.

This is one of the list.

Domestic: Dogs and cats.

Peridomestic: Cows and buffaloes, pigs, sheep and goats, donkeys, horses, camels.

Wild: Foxes and jackals, monkeys, mongoose, bears, tigers, bats.

Not reported: Rodents, birds, squirrel.

Mode of Transmission

The virus is introduced through wounded or abraded skin or mucous membrane when the infected animal *licks* or *bites* another animal or man. From the skin it travels along the nerve sheaths to the central nervous system from where it finally reaches, along the nerves, to the salivary glands.⁷ Occurrence of viremia in rabies has also been demonstrated. In the only documented instance of spread from man to man, transmission occurred through corneal transplantation.⁸

Virus enters the wound → Multiplies locally in muscle fiber → Peripheral nerves → Dorsal root ganglia → Spinal cord Brain.

SUSCEPTIBILITY

Most animals are susceptible, especially some species of dogs and jackals. Man, especially dog handlers and children, are exposed more. 10 to 30 percent of the persons bitten by rabid animals develop rabies, but mortality is cent percent.

Period of Communicability

The animal is infective 3 to 5 days before the onset of symptoms and during the course of disease, hence the dog is watched for symptoms or death for 10 days. If the animal remains healthy and alive for at least 10 days after the bite, antirabies treatment is not indicated.

Incubation Period

It is variable, usually 2 to 8 weeks. Rarely it may be less than 15 days or more than one year. The length of incubation period depends upon:

- The distance between brain and the site of the wound. Average incubation periods are 60, 40 and 30 days respectively after bites on legs, arms and head.
- Richness of nerve supply on the part bitten. Genitals and face, for example, have rich nerve supply.
- Number, size and depth of the wounds.
- The nature of the animal; jackal bites are the worst.
- Physical condition of the patient.
- Whether the bite is through bare skin or through clothes.
- Promptness of local treatment.
- Antirabies vaccination.
- Age of the victim (children have faster onset).

Methods of Control

Prevention of rabies has two aspects: Prevention of disease in man and control of disease in dogs.

PREVENTION OF DISEASE IN MAN

Once man gets infected with rabies virus, the course is almost always fatal, though rare instances of recovery have been recorded.³ There are three main stays of prevention—local treatment, vaccination and immunoglobulin administration.

Local Treatment

Wounds should be categorized as given below because treatment and outcome depend upon the nature of wound.

Category of bites and management⁵

Category I exposure:

- Touching or feeding of animals
- Licks on intact skin

Management: No treatment is required, if history is reliable.

Category II exposure:

- Nibbling of uncovered skin
- Minor scratches or abrasions without bleeding
- Licks on broken skin

Management: Wound treatment and modern tissue culture vaccine (5 injections).

Category III exposure:

- Single or multiple transdermal bites or scratches
- Contamination of mucous membrane with saliva (i.e. licks)
- Exposure to bats, whatever the nature of contact

Management: Wound treatment, rabies immunoglobulin (RIG) and modern tissue culture vaccine.

Local treatment is described in two parts—the first aid to be rendered by the victim himself or his attendant, and the measures to be taken by a doctor.

1. *First aid:* Elimination of rabies virus from the site of infection is the most important protective measure. This is done by physical means (washing and flushing the wound well with soap solution, detergent solution or water alone) and chemical means (applying 70% ethanol or tincture iodine or aqueous iodine) after washing the wound.³
2. *Treatment by doctor*
 - Antirabies immunoglobulin should be applied by instilling in the depth of the wound and by infiltrating around the wound.
 - Suturing should be postponed. If suturing has to be done, it should be done after applying immunoglobulin locally as described above.
 - When indicated, antitetanus treatment and antibiotics should be started to control infection other than rabies.

Antirabies Vaccine (ARV)

Rabies is one of the few diseases where active immunisation is done after man has become infected. This is explained by the long incubation period of rabies. ARV should be administered immediately in category II and III exposures. However, it should be stopped in the following two instances:³

1. When the animal remains healthy throughout the observation period of ten days (in case of cats and dogs).
2. When the animal is killed and found to be free of rabies by laboratory tests (WHO recommends that all animals other than cats and dogs, except when they belong to threatened or endangered species, should be killed humanely and the tissues examined in the laboratory for rabies). Three types of vaccines are available. These are shown in **Table 20.1**. A brief description is given below:

Nerve Tissue Vaccines

The first vaccine of this type was a crude live vaccine prepared by Pasteur in 1885. In 1919, Semple prepared an inactivated form.

TABLE 20.1: Currently available antirabies vaccines

Types of substrate	Vaccine
Nervous tissue	Semple's sheep brain* Suckling mice brain
Duck embryo	Duck embryo vaccine (DEV) Purified duck embryo vaccine (PDEV)
Tissue culture	Human diploid cell vaccine (HDCV)* Primary chick embryo cell vaccine (PCECV)* Purified Vero cells rabies vaccine (PVRV)* Fetal rhesus cells (rabies vaccine adsorbed-RVA) Fetal bovine kidney cell rabies vaccine Primary hamster kidney cell rabies vaccine

*Available in India

Duck Embryo Vaccine (DEV)

It has been in use in many countries, but not in India, since 1956. It is economical and easy to prepare, with less side effects compared to neural tissue vaccine. A purified vaccine (PDEV) is now available which is claimed to have a level of safety and immunogenicity comparable to tissue culture vaccines including human diploid cell vaccine.⁹

Tissue Culture Vaccines

Being derived from cells of nonneural origin, these vaccines are safe as well as potent. Human diploid cell vaccine (HDCV) was the first to be prepared. Primary Chick Embryo Cell (PCEC) rabies vaccine is also now available worldwide. The least in the international market is purified vero cell rabies vaccine (PVRV) which is produced in VERO cells procured from African green monkey kidneys. PVRV has now replaced HDCV as the WHO reference vaccine for rabies. The three vaccines HDCV, PCEC and PVRV are similar in most respects except that the dose of PVRV is 0.5 ml per injection compared to 1 ml for the other two. Each dose has a minimum vaccine content of 2.5 IU. An oral antirabies vaccine for dogs has been developed and tried successfully in Germany.¹⁰ An oral antirabies vaccine for human use will be a major breakthrough.

Meanwhile Government is doing more to promote rabies awareness with initiatives such as a pilot project to prevent human rabies death launched by the National Center for Disease Control (NCDC) – formerly NICD in five Indian cities.⁵

Dosage Schedule³

Practice varies as regards number of doses, route and amount of vaccine per dose.

Tissue Culture or Duck Embryo Vaccines

The potency is at least 2.5 IU per dose. The following schedules are used:

Intramuscular schedule: One dose of the vaccine is administered on days 0, 3, 7, 14 and 30. All intramuscular injections must be given in the deltoid region or, in small children, in the anterolateral area of the thigh. Vaccine should never be administered in the gluteal region.

In the abbreviated multisite schedule referred to as the 2 to 1 to 1 regimen spanning over 21 days instead of the 30 days schedule described above, one dose each is given in the right and left arms on day 0, followed by a dose on day 7 and one on day 21. The 2 to 1 to 1 schedule induces an early antibody response and may be particularly effective when post-exposure treatment does not include administration of rabies immunoglobulin.

TABLE 20.2: Regimens for post-exposure prophylaxis (Intradermal route)

Route	Regimen	Dose	Schedule (Days)
Intradermal	Two-site*	0.1 ml	Day 0, 3, 7, 28†
Intradermal	Eight-site‡	0.1 ml	Day 0 (8 doses§), 7 (4 doses#), 28¶, 90¶

* Two site regimen signifies right and left upper arm (total 2 sites)

† On each day, one injection is administered in right and left upper arm

‡ Eight site regimen signifies both upper arms, both lateral thighs, both suprascapular regions and both sides of the lower quadrant region of the abdomen (total 8 sites)

§ One injection each in both upper arm, both lateral thigh, both suprascapular region, and on both sides of the lower quadrant region of the abdomen (total 8 doses)

One injection each in both upper arm and both lateral thigh (total 4 doses)

¶ One dose in one upper arm only

Intradermal Schedule¹¹

Eight out of India's 28 states and seven Union Territories had announced plans to introduce intradermal regimen from 2009.⁵ Only PCEC and PVRV has been accredited for ID use by WHO and DCGI (**Table 20.2**).

The 2 site ID schedule is known as **Updated Thai Red Cross Schedule**, where 0.1 ml each (total 0.2 ml in two sites) tissue culture ARV is administered on both deltoid areas (alternative site is anterior aspect of both thigh) ID route involving two different lymphatic area drainage sites. For ID route 1 ml insulin syringe with 28 G fixed needle is required and 70 percent ethanol or isopropyl alcohol is used as skin disinfectant.

ADVANTAGE OF INTRADERMAL SCHEDULE

- Low dosage is necessary – only a fraction of intramuscular dose is required.
- This is a vaccine saving schedule.
- It is cost effective, thus economical.
- Less number of doses are required, so patient compliance is better. Thus saving of man days, expenses and clinic hours.
- Immune response is developed early, so better efficacy.
- Less or no dilution in blood after dermal inoculation.
- It yields stronger immune status even in compromised persons.
- It yields stronger immune status even in compromised persons.

However intradermal route is not preferred in the situations like diabetes mellitus, hepatic insufficiency, malnutrition, antimalaria therapy, steroid or antiviral therapy and HIV infection. Mixed schedule involving ID and IM route is also not recommended.

In the following situations the first dose of the vaccine is given in double doses (whatever schedule is used):

- Patients with chronic diseases like cirrhosis of liver and severely malnourished patients.
- Patients who are congenitally immunodeficient or suffering from AIDS.
- Patients on immunosuppressive drugs like corticosteroids.
- If there is significant delay in presentation.

Nerve Tissue Vaccines

It has been discontinued. Painful injections were given subcutaneously on anterior abdominal wall with large bore needle.

Antirabies Immunoglobulin

Combined immunoglobulin-vaccine treatment is considered by WHO³ as the best specific systemic treatment available for the postexposure prophylaxis of rabies in humans, although experience indicates that vaccine alone is sufficient for minor exposures (category II in **Table 20.1**). Immunoglobulin should be given in a single dose of 20 IU per kg of body weight when human 'antirabies immunoglobulin is used and 40 IU per kg of body weight when heterologous (equine) immunoglobulin is used. Immunoglobulin may be given at a different site but at the same time as the first dose of antirabies vaccine. Sensitivity to heterologous immunoglobulin must be determined before it is administered. Adequate precautions should be taken to deal with anaphylactic reaction.

All category III bites and all proven rabid animal bite or scratches should receive immunoglobulin. Rabies immunoglobulin (RIG) is infiltrated into all wounds, as much as possible into and around the wounds, remaining immunoglobulin if any is to be given IM at a site away from the site where vaccine has been administered. If RIG is insufficient in volume, then dilution is done with sterile normal saline (up to equal volume or maximum 3 times volume). RIG can be given irrespective of the interval between the time of exposure and initiation of vaccine treatment. It can also be given up to day 7 after administration of the first dose of vaccine (ARV).

Missing out the administration of RIG along with active immunization, in cat III exposures, is liable for punishment under Consumer Protection Act.

Repeat Bites

Patients who have previously received a complete course of primary immunization (pre or post exposure) should receive only two booster doses either IM (1 ml) or ID (0.1 ml); one on each of days 0 and 3, respectively.

Efficacy of Vaccination

It depends upon the extent to which the course of injections is completed. Studies at the National Institute of

Communicable Diseases¹² show that one-fourth of cases who had received only seven injections, failed to show seroconversion. Seroconversion was found in all cases who had received 8 injections or more.

Reactions to Treatment

Mild reactions might occur at the site of injection such as pain, reddening and swelling. The modern tissue culture vaccine is quite safe and effective. Considering 100 percent fatality of the disease, contraindications are not considered. Pregnancy, lactation and infancy are never contraindications to post exposure rabies vaccination.

The most serious complication is postvaccinal paralysis or encephalitis. This occurs usually 5 days after the first injection to 14 days after the last. Complete recovery is usual but there is 5 percent mortality in cases of encephalitis. Such complications are rare, occurring once in 12000 to 16000 cases in India.⁷ Antirabies serum produces serum sickness in 15 to 25 percent of the recipients.⁷

Prophylactic Vaccination

Persons at high risk of infection, such as dog catchers, veterinarians and laboratory workers, should be given preexposure prophylaxis. The preferable regimen is to give three intramuscular doses (at least 2.5 IU per dose) of tissue culture vaccine on days 0, 7 and 28 given in deltoid region. Anterolateral area of thigh may be used in young children. Gluteal region should never be used because this is associated with lower serum levels of virus neutralising antibody. These levels should be tested every six months in persons given preexposure rabies vaccine. A booster should be given whenever antibody titre falls below 0.5 IU ml.³

Preexposure vaccination simplifies therapy by eliminating the need for rabies immunoglobulin (even in Cat III exposure) and decreasing the number of doses of vaccination needed (2 doses of TCv on day 0 and 3).

CONTROL OF DISEASE IN DOGS

In India, dog population is estimated to be about 1 percent of the human population. It was found in an urban survey that one-third dog bites are caused by pet dogs and two-thirds by stray dogs.¹³ The following control measures are applicable in urban areas.

- Licensing of pet dogs
- Impounding and elimination, if necessary, of stray and ownerless dogs
- Muzzling of pet dogs
- Compulsory immunization of all pet dogs.

The long-term aim of WHO is elimination of rabies in dogs through a combination of injectible and oral immunization campaign.

Dog rabies control is relatively simple. It is necessary to vaccinate 70 percent of total dog population, in a short period of time and to maintain the immune coverage

and protect the area from spillover through control of dog movement.¹⁵ However, a history of rabies vaccination in an animal is not always a guarantee that the biting animal is not rabid. Animal vaccine failures may occur because of poor quality or improper administration of vaccine, poor health status of the animal and one vaccine dose not always provide long lasting protection.

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Rat Bite Fever (ICD-A25.0 and A25.1)

IDENTIFICATION

There is a history of rat bite. The wound heals but pain and swelling appear at the site of wound after two to six weeks. The scar breaks down and lymphadenitis and lymphangitis occur. General symptoms appear after some time in the form of fever and a specific rash (purple red spots over the neck, trunk and face) which slowly disappear. The temperature comes down after 3 to 4 days. Relapses and remissions may occur for months and years.

Causative Agent

Rat bite fever can be the result of two different infections, both producing almost similar clinical picture. These are spirillosis (ICD-A25.0) caused by a spirochete *Spirillum minor* and Streptobacillosis (ICD-A25.1) caused by *Streptobacillus moniliformis*. The variety found in Asia is spirillosis. The description given below pertains to this.

Laboratory Diagnosis

It is difficult to find the causative agent, *Spirillum minor*, in blood. The patient's blood is, therefore, injected into white rat or mice. The injected animal's blood shows the organisms in abundance.

OCCURRENCE

The disease is found in Japan, China and India but cases are also reported from Europe, Africa and Australia. Rats and mice all over the world have been found to be healthy carriers. Infection occurs when an infected rat bites a healthy person and introduces the germs through the skin wound.

Susceptibility and Resistance

There is general susceptibility. Mortality is 10 percent in untreated cases.

Incubation Period

2 to 6 weeks.

Methods of Control

Anti-rat measures and curative treatment with penicillin.

Leptospirosis (Weil's Disease) (ICD-A27.9)

IDENTIFICATION

- *Stage of invasion:* Fever and prostration for 4 to 5 days; muscular twitchings; pain in calf muscles; intense injection of conjunctiva.
- *Icteric stage:* Jaundice in 60 percent cases for 5 to 7 days with enlarged and tender liver. Hemorrhages may occur. Death occurs in about 10 percent cases. Urine shows albumin, bile and leptospira organisms since the infection becomes localized in the kidneys.

DIAGNOSIS

Blood culture is positive during the first week of illness. Urine culture is positive after the first week. Serological tests reveal rising titer.

OCCURRENCE

The disease is found worldwide including Japan, USA, France, Germany and Sweden. In India, cases have been reported from Andamans and Kolkata. Prevalence is higher in miners, sewer workers, fishermen, swimmers and dock workers due to higher risk of exposure. Scores of persons reportedly died of leptospirosis in Ernakulam district of Kerala in 1993 and 1994.¹

Infectious Agent

Weil's disease is caused by a spirochaete called *Leptospira interrogans*. A common serovar (serological variant) is *L. interrogans icterohaemorrhagiae* discovered in 1915. It is sensitive to hydrochloric acid in the stomach and to free chlorine in water at a concentration of 0.3 ppm. It can live for months in water and in wet or damp soil when passed in the urine of field rodents, foxes, and domestic animals like sheep and dog which form the reservoirs of infection. When healthy persons come in contact with water, mud and soil contaminated with urine of rats, the spirochaete makes way through the skin abrasion or even intact skin and, sometimes, through conjunctiva and mucous membranes of the intestines. There is no natural immunity.

Incubation Period

9 to 10 days.

Methods of Control

Adopt antirrat measures. Avoid contact with polluted soil or water by wearing shoes and clothings. Treat all cuts and wounds promptly. Penicillin and tetracycline cure the disease within a few days. Polyvalent vaccines have given good results.

Reference

1. *Times of India*, 23 to 6 to 1994.

Anthrax (ICD-A22.9)

IDENTIFICATION

Anthrax is primarily a disease of animals, most commonly of cattle, sheep, pigs and goats. It occurs in man in three forms:

1. *Cutaneous anthrax* or malignant pustule (Hideporter's disease): It affects the skin. The lesion starts as a papule, becomes a vesicle and develops into black eschar with hard swelling.
2. *Pulmonary anthrax* (Wool-sorter's disease): It affects the lungs. Symptoms resemble pneumonia. Sputum contains clotted blood and spores of anthrax bacillus.
3. *Intestinal anthrax*: It affects the intestines. Shivering, septicemic and hemorrhages from all openings are the characteristic features of all three forms.

Diagnosis is confirmed by finding anthrax bacilli in lesions or discharges.

EPIDEMIOLOGY

Anthrax occurs all over the world, especially in the tropics. It is caused by a spore bearing organism,

Bacillus anthracis, the largest of all bacteria in size. Spores can stand boiling for 5 minutes but die easily at 105°C. Bacilli exposed to air rapidly from spores. The reservoirs of infection are horses and animals such as cattle, sheep, goats and pigs. The disease is contracted as below:

- A malignant pustule is formed when spores enter the skin. This may occur when a person carries cattle hide on his back, which may cause cutaneous abrasions. Infected fur coat, hide products and shaving brushes may also be the source of infection.
- Spores are inhaled from horse hair and from wool of the infected sheep as happens in wool sorter's disease or pulmonary anthrax.
- Spores ingested with improperly cooked meat of infected cattle cause intestinal anthrax. There is no evidence of transmission through milk of infected animals.

Incubation Period

It is usually 2 to 5 days; that of the pulmonary form may be as short as 1 day.

Methods of Control

- *Measures directed towards animals*: All suspected animals should be isolated and killed. Meat animals should be inspected before slaughtering and meat should be inspected before sale. Proper cooking of meat should be ensured. Wool animals should be protected by giving anthrax vaccine.
- *Measures directed towards man*: Contact with infected animals should be avoided. All cuts and wounds should be immediately attended to and treated with penicillin. Broad spectrum antibiotics and sulphadiazine are also effective for treatment of the disease. Health education about the mode of spread and the measures of prevention is essential.
- *Prevention of spread through environment*: The practice of carrying hides, wool and fur on bare back should be discouraged and these should be adequately disinfected. All shaving brushes should be thoroughly sterilized to kill spores by soaking in 10 percent formalin at 43°C for four hours. Wool bundles should be soaked in caustic soda to loosen blood clots, dust, etc. and then kept in hot 5 percent formalin solution for 2 to 3 hours to kill all germs. All waste hair and wool dust from a wool factory should be burnt. A cell free vaccine for high risk persons, such as veterinarians, is available in the United States.

Glanders (ICD-A24.0)

Glanders is a disease of horses, mules and asses caused by *Pseudomonas mallei*, also known as *Malleomyces*

mallei and *Pfeifferella mallei*. It spreads from horse to horse through infected managers or drinking troughs. Very rarely, it is transmitted to man by direct contact. Incubation period in man is 4 days.

Other Infections

This chapter was meant to include diseases that could not be classified as respiratory, intestinal, contact or arthropod-borne infections but could be regarded as zoonoses. However, there are some other infections which cannot be grouped under any of the above five categories. Examples are tetanus, actinomycosis and moniliasis. Out of these, tetanus will be described here in detail.

Tetanus (ICD-A33, A34, A35)

The usual form of tetanus is labeled as ICD-A35. Neonatal tetanus and obstetric tetanus are labelled as A33 and A34 respectively.

IDENTIFICATION

It is a highly fatal disease characterized by tonic spasm of muscles, primarily those of jaw and neck. Muscles of the trunk are also markedly involved. Prognosis is poor if convulsions start within 48 hours after lock-jaw. If the patient survives for 10 days, the prognosis becomes better each day and the chances of survival are almost 100 percent after 14 days. Rigidity is sometimes confined to the site of injury where toxin is produced by the tetanus bacillus.

The spores can withstand heat, cold and drying and can survive for years. They resist boiling for 5 minutes but are killed by:

- Autoclaving at 105°C
- Exposing for one hour to dry heat at 160°C
- Contact with 2.5 percent tincture iodine for 6 hours
- Contact with 5 percent phenol for 15 hours.

OCCURRENCE

Tetanus occurs all over the world. The incidence is higher in agricultural and rural communities, especially where nightsoil and manure are used as fertilizers.

The universal immunization programme has resulted in significant reduction in tetanus. That is why WHO set the target of eliminating neonatal tetanus by 1995.

RESERVOIR

Clostridium tetani is a normal inhabitant of the intestines of ruminants, horses and most domestic animals. Spores are widely distributed in superficial layers of soil and are found in all sorts of articles covered with dust. Bacilli are found in human excreta in varying proportions, may

be in about 10 to 20 percent population. They may also be found on human skin and in middle ear discharge.

Mode of Transmission

Infection occurs when spores enter the body through injury, which may be conspicuous or too trivial and unnoticed. It is often impossible to predict which wound will or will not lead to tetanus infection. Conditions known to predispose to tetanus are: (i) punctured wounds, (ii) wounds associated with obvious tissue damage, especially when contaminated with street dust, (iii) presence of foreign matter or necrotic tissue which encourage growth of anaerobic pathogens, (iv) wound infection by aerobic organism creating anaerobic conditions, and (v) contaminated infections, especially in drug abusers. When anaerobic environment is available, especially in the presence of dead tissue, the tetanus spores germinate, bacteria proliferate and toxin is produced. The toxin ascends up the motor nerves and gains access to central nervous system. In an early study, the authors found the following frequency of conditions associated with tetanus (**Table 20.3**).⁵

Neonatal tetanus has been reportedly responsible for 0 to 27 percent of all tetanus cases.⁵ As regards tetanus following trauma, one person out of 6003 sustaining an injury was reported as having developed tetanus. It is alarming to note that an apparently innocuous procedure like intramuscular injection accounted for 0.5 to 1.3 percent cases of tetanus.

Incubation Period: It is 4 to 21 days depending upon character, extent and location of the wound. In 60 to 80 percent instances it is more than 7 days, the average being 10 days. Prognosis is bad if incubation period is less than 7 days.

Period of Communicability: There is no such period in reference to tetanus because it is not transmitted from person to person.

Susceptibility and Resistance: There is general susceptibility in the population. Active immunization by tetanus toxoid provides immunity for at least ten years.² Infants born to immunized mothers have passive immunity that prevents against neonatal tetanus. Tetanus

TABLE 20.3: Frequency of conditions associated with tetanus

• History of injury (traumatic tetanus)	40 to 50%
• Suppurative otitis media (otogenous)	10 to 20%
• Umbilical cord infection (neonatal tetanus)	10 to 15%
• Uterine or post-partum infection (puerperal and post-abortion tetanus)	5 to 20%
• Miscellaneous (burns, furuncles, ulcers in mouth, tattooing, vaccination, injections, postoperative period, etc.)	4 to 5%
• Idiopathic or cryptogenic tetanus	5 to 10%

TABLE 20.4: Guidelines for tetanus prophylaxis

Immunization status (Number of doses)	Clean minor wounds		All other wounds	
	TT	TIG	TT	TIG
Uncertain or less than 3	Yes	No	Yes	Yes
3 or more	No*	No	No**	No

*Yes, if more than 10 years ago

**Yes, if more than 5 years ago

Immune Globulin (TIG) or tetanus antitoxin (horse antiserum), provide only transient immunity. Tetanus infection may not confer immunity and second attacks can occur. Hence primary immunization is indicated after recovery from tetanus.²

Methods of Control

- **Local treatment:** Thorough cleaning of all wounds is essential, taking special care to remove foreign matter and dead tissue.
- **Tetanus immune globulin:** TIG should be administered in case of unimmunized individuals or large, contaminated wounds, as indicated in **Table 20.4**. The dose is 250 to 500 units. If TIG is not available, ATS (equine antitetanus serum) may be used in a dose of 1500 to 3000 units in serious conditions like puncture wounds, crush injuries, compound fractures, burns and puerperal sepsis, taking the precautions for anaphylaxis.⁶
- **Active immunization:** Primary immunization is carried out by giving three doses of tetanus toxoid, usually as DPT. Immunity is long lasting and may be life long.³ Adequate levels last for at least 10 years, at which interval booster doses should be given.² Adequate immunity is indicated by serum antitoxin level of 0.01 IU per ml. Frequent administration of TT should be avoided. Reaction to TT is more likely if excessive doses of TT have been given.²

Neonatal Tetanus

Neonatal tetanus remains one of the major as well as preventable causes of neonatal death in a number of developing countries.^{1,2} The disease is primarily caused by a lack of hygiene during delivery, and it usually occurs when the umbilical cord is contaminated while it is being cut with a nonsterile instrument, or dressed. Symptoms, in the form of spasms, begin 3 to 14 days after birth. Without specific treatment more than 95 percent of infants with neonatal tetanus die, and even with treatment 10 to 90 percent die, depending on the intensity of supportive care.³ Community-based studies in developing countries have reported case–fatality ratios ranging from 25 to 100 percent.⁴ Evidence suggests that a significant proportion of infants surviving neonatal

tetanus suffer from brain damage, which manifests as neurological abnormalities and developmental impairments.^{5,6}

STANDARD CASE DEFINITION⁷

Suspect (history): Any neonatal death between 3 and 28 days of age in which the cause of death is unknown, or any neonate reported as having suffered from Neonatal Tetanus (NT) between 3 and 28 days of age and not investigated.

Probable (history and clinical examination): Any neonate with normal ability to suck and cry during the first 2 days of life and who, between 3 and 28 days of age, cannot suck normally and becomes stiff or has spasms.

Confirmed (laboratory tests): The basis for case classification is entirely clinical and does not depend upon laboratory confirmation. NT cases reported by physicians are considered to be confirmed.

Treatment

- Excellent 24-hour-a-day nursing care in a referral hospital, with careful use of drugs can reduce the case fatality rate in neonatal tetanus from 80 percent to 50 percent or lower.
- Individuals who recover from tetanus do not have natural immunity and can be infected again and therefore need to be immunized.

Prevention

- Immunization of infants and children with DPT/DT/TT vaccine according to the NIS.
- Immunization of women of childbearing age with TT, either during or outside of pregnancy.
- Clean practices (5 C's: Clean hand, clean surface, clean blade, clean cord tie and clean cord stump) during and after child birth, even if the pregnant woman has been immunized.

In 1989 the World Health Assembly called for the elimination of neonatal tetanus. UNICEF, WHO and the United Nations Population Fund have set the year 2005 as the target date for worldwide elimination of the disease.¹ As of mid-2004, the focus of global efforts is on 51 countries that have not yet eliminated the disease and on six countries that seem to have eliminated the disease. (Global elimination of neonatal tetanus is defined as the reduction of cases to fewer than 1 per 1000 live births in every district in every country).⁶

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Emerging Infections¹

The theme of the World Health Day on 7th April 1997 was "Emerging infectious diseases-Global response, global alert". The reemergence of diseases thought to be well under control in large parts of the world and emergence of new infections with high case fatality rates and the potential of their rapid spread has led the WHO to issue a wake up call. The eradication of smallpox and effective control of many communicable diseases, has led to a false sense of security and complacency in many countries. Resources for public health were curtailed as more immediate priority areas were identified for financial support.

The outbreaks of plague in 1994, cholera in 1995 and dengue hemorrhagic fever in 1996, among many others, have highlighted the urgency for strengthening the disease surveillance system so that early warning signals are recognized and appropriate control measures are initiated in a timely manner.

Various factors are responsible for the emergence and reemergence of communicable diseases. These multisectoral factors will need to be addressed while developing strategies for their prevention and control. Some of these factors, apart from weak public health system, include rapid urbanization, industrial and other developmental activities, encroachment by humans of areas so far uninhabited leading to ecological changes and rapid means of transportation to and from any part of the world. Improvements in living standards are sometimes accompanied with potential health hazards.

Emerging infectious diseases have been defined by WHO as *those infections the incidence of which in*

TABLE 20.5: Emerging diseases

- Acquired immunodeficiency syndrome (AIDS)
- Cholera due to *Vibrio cholerae* O 139
- Tuberculosis, hepecially due to multidrug resistant organisms
- Malaria
- Kala-azar
- Dengue, DHF and DSS
- Hepatitis B, C and E
- Japanese encephalitis
- Rabies
- Antimicrobial resistance

TABLE 20.6: Reasons for emergence

- Environmental degradation
- Uncontrolled urbanization
- Unhygienic living conditions
- Migration of population
- Natural disasters
- Growing international trade, tourism and rapid travel
- Alterations in microorganisms
- Resistance to antimicrobials
- Insecticide resistance
- Weak public health system

TABLE 20.7: Potentially emerging diseases

Infection	Reported in
Hanta virus	Myanmar, Sri Lanka, USA
Yellow fever	Kenya, many African and Latin American countries
Ebola virus	Zaire, South Africa
<i>E. coli</i> O 157:H7	Australia, South Africa, Japan, USA

humans has either increased during the last two decades or threatens to increase in near future. The term includes newly-appearing infectious diseases or those spreading to new geographical areas. It also refers to those diseases which were previously easily controlled by antimicrobials but have now developed resistance to these drugs.

Reemerging infectious diseases are those that have reappeared after a significant decline in their incidence. Appearance of plague in an explosive form in 1994 after a period of quiescence of almost 27 years is an important example of reemerging infections.

List of some emerging diseases is given in **Table 20.5**. Main reasons for emergence are given by **Table 20.6**. Some potentially emerging diseases are listed in **Table 20.7**.

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Epidemiology of Noncommunicable Diseases

Introduction

Communicable diseases have been controlled to a considerable extent in the developed countries. On the other hand, there is a trend towards increase in prevalence of noncommunicable diseases due to ecological imbalance and changing lifestyle of man. The pattern of communicable diseases has undergone a change in developing countries like India also. For example, smallpox has been eradicated, guinea worm infection is almost so and massive programs are under way to control tuberculosis, filariasis and leprosy. In contrast the incidence of noncommunicable disease is increasing. The following noncommunicable diseases are probably on the increase in India:

- Cancer and cardiovascular diseases
- Psychosomatic diseases
- Respiratory allergy
- Food poisoning and food allergy due to wilful adulteration or accidental contamination of food.
- Occupational hazards such as pneumoconiosis and poisoning due to lead, manganese and chromium.
- Psychiatric disorders including delinquency and suicides.
- Diseases caused by exposure to harmful agents like radioactive substances and insecticides.
- Accidents
- Addiction
- Diabetes
- Blindness
- Limitation of mobility due to increasing age.

Epidemiology developed initially in reference to the study of communicable diseases. The epidemiological approach was highly successful in control of such diseases. During last few decades, the epidemiological approach has been applied to the study of noncommunicable diseases also so as to achieve better control of the latter. Using epidemiological approach, one has to search for disease related factors in the host, the agent and the environment. It may be noted that the agents are living organisms in case of communicable diseases but nonliving in case of noncommunicable diseases. An illustrative example of this concept is the case of a vehicle accident in which the driver is injured. A casual query might elicit the

reply that the cause of the accident is the bump or mechanical force with which the vehicle has hit the victim. But this is only partly correct, since many other causes are at work. In order to analyze the cause fully, one has to consider the agent, host and environmental factors as illustrated below.

<i>Agent factors:</i>	Mechanical force with which the host is hit
<i>Host factors:</i>	Driver's age, habits, driving skills, personality, physical and mental state, etc.
<i>Environmental factors:</i>	Intensity of traffic, type of road (width, curves, surface, etc.), lighting, traffic signals, etc.

Thus, if it is sought to undertake a program to reduce the number of vehicle accidents in a city, all the above factors will have to be given due consideration. The utility and relevance of the epidemiological approach in this example is obvious. The same is true of other noncommunicable diseases, most of which have multiple etiology though a particular factor may play more prominent role. Some important noncommunicable diseases are cancer, cardiovascular diseases, diabetes, accidents, malnutrition, blindness and mental illness. The last, will be described in detail in the chapter on Mental Health. Malnutrition is discussed in the next chapter while the others are described here. Other noncommunicable diseases include arthritis, nephritis, peptic ulcer, appendicitis, asthma, congenital defects and radiation injury.

STANDARD METHODS OF STUDY

The standard format for description of noncommunicable diseases is given below.

- *Introduction:* Describes the nature of the problem.
- *Magnitude:* Discusses the size and extent of the problem, including prevalence and incidence. Mention whether the disease is on the increase or decline.
- *Prepathogenesis*:* Discusses the agent, host and environment factors as in case of communicable diseases.

*Study of prepathogenesis means the study of etiological factors in the agent, the host and the environment before the disease process (Pathogenesis) actually starts

- *Agent factors*: These may be physical agents, chemical agents and nutrients. Their nature and relationship to man and environment should be discussed.
- *Host factors*: They include:
 - i. Age, sex and race
 - ii. Heredity and constitution
 - iii. Habits customs and lifestyle
 - iv. Defence mechanisms, leading either to acclimatization to stimuli (such as heat and cold) or to sensitization (i.e. development of allergy or hypersensitivity)
 - v. Physical and psychological states.
- *Environmental factors*:
 - i. *Socioeconomic*: Social status, educational level, political climate and economic pattern
 - ii. *Physical*: Climate, season, water, air, food, housing, etc.
 - iii. *Biological*: Viruses, bacteria, parasites, vectors, fungi and other animals and plants.
- *Pathogenesis*: Discusses the evolution of disease as per the following sequence:
 - Latent period
 - Early manifestations
 - Late stage
 - Remote effects
 - Chronicity and death.
- *Prevention and control*: The control measures are described as related to the five levels of prevention as follows:
 - Health promotion, done mainly by health education and efforts aimed at raising the general standard of living.
 - Specific protection by known specific measures against specific causative factors in the agent host and environment.
 - Early diagnosis and prompt treatment
 - Disability limitation
 - Rehabilitation by physical, social, psychological and vocational support.

Cancer

Introduction

The term cancer includes all malignant tumors arising in the body tissues. It is important to remember that cancer need not always be fatal. One case in three is curable by modern methods;¹ even one out of two may be curable if diagnosed and treated early.² In any case, early diagnosis and treatment prolong survival in most cases of cancer. It ought to be emphasized that most cancers are preventable. Changes in nutritional pattern and personal habits hold the key to prevention of cancer.³

History and Prevalence

Cancer has been known since Vedic times in India and is described in Sushruta Samhita. Evidence of cancer has been found in mummified bodies in Egypt. Kangri cancer in Kashmir and oral cancer in other parts of India came into prominence at the end of 19th Century. Cancer is responsible for 5 million deaths in the world every year out of a total of 50 million.⁴ In the majority of developed countries, cancer is second only to cardiovascular diseases as a cause of death. Not only this, the incidence of cancer is steadily increasing. Among males, age specific risks of dying from cancer have been decreasing for a few sites, such as the stomach and the esophagus. However, mortality for other cancers is either stationary or continues to increase. An example is that of the cancers associated with tobacco smoking. Age specific death rates from cancer in females exhibit a decline for sites such as the stomach and the cervix uteri, but the available evidence suggests a worsening of the situation for cancer of the breast, the leading cause of death among middle aged women. Lung cancer is increasing in females also in many developed countries.

Noncommunicable Diseases

It is estimated that there are nearly 2.0 million cancer cases in India at any given point of time, Nearly 0.7 million new cases occur every year.⁵

In contrast to the developed countries, data from Bombay suggest that cancer was the ninth leading cause of death, accounting for 4.3 percent of all deaths in Bombay.⁶ The most common sites of cancer in India are cervix, breast, esophagus, pharynx, tongue and mouth. Oral cancer, specially of the buccal mucosa, is particularly common in South India, Uttar Pradesh and Bihar. The occurrence of oropharyngeal malignancy is strongly associated with the habit of chewing betel leaf, areca nut and tobacco, as also with smoking. Certain *pan masalas*, whose use has markedly increased during last few years, are also carcinogenic.

Data from six metropolitan and one rural cancer registry in India show that the five most common cancers in India are cancer lung (10.6%), pharynx (9.1%), esophagus (6.7%), tongue (6.6%) and stomach (5.7%) among the males. In women, cancer cervix (23.5%), breast (19.3%), ovary (5.5%), esophagus (4.4%) and mouth (3.9%) are the five most common sites.⁷ The most common cancer in all the registries (except Chennai where stomach cancer was the most common) was either lung or esophagus among the males. The most common cancers among women in all the registries in the country are cancer cervix, breast, ovary, stomach, esophagus and oral cavity. The leading causes of cancer have remained consistent over the years in all the registries in the country except at the rural registry at Barshi (Maharashtra).⁸

In a population-based study in rural South India, mouth cancer followed by tongue, hypopharynx, esophagus, and larynx were the most common cancer in men. Thus head and neck cancers account for half of all male cancer cases. In females cervical cancer (which accounted for half the cases in females), followed by breast and mouth were the most common cancers.⁹

The figures regarding oral cancer are really alarming. Mouth cancer is a major health problem in many parts of the world. On the Indian subcontinent and in other parts of Asia it remains one of the most common forms of cancer. The incidence rates in the Indian subcontinent and parts of Asia are in excess of 10/100,000 per annum.¹⁰ Its global prevalence is six million (roughly one per 1000) cases at present. Of these, three million are in South East Asia, but India alone accounts for 2.5 million cases. It is estimated that 50,000 new cases occur annually in India, but this number will increase to 10 to 12 laks once the average age increases to 70 to 75 years. Oral cancer accounts for 28 percent of the total cancers in India and constitutes about 10 percent of all head and neck cancers. The high prevalence of oral cancer is particularly tragic in view of the fact that it is largely a preventable cancer and the use of tobacco is associated with a 10 to 30 to fold risk. Beside tobacco chewing, other common etiologic factors are use of betel leaf (pan), lime and other irritants like chilli.¹¹

Oral cancer is particularly common in Orissa. A recent report suggests that half of India's oral cancer patients are from Orissa alone, especially coastal Orissa in the triangular zone comprising Nayagada, Puri and Paradeep. Middle-aged rural women are the main victims. It is estimated that an average person in this zone chew 20 'pans' a day for 15 years.

Population-based data reveal that gallbladder cancer is very high in Northern Indian cities (5 to 7/100,000 women) and low (0 to 0.7/100,000 women) in southern India. The distribution suggests a high incidence region for gallbladder cancer comprising the States of Uttar

Pradesh, Bihar, Orissa, West Bengal and Assam. The cancer is twice as common in women and is the leading cancer among all digestive tract cancers in Northern India. This high incidence is also observed among North Indian immigrants to the United Kingdom. Time trends reveal an increase in incidence of gallbladder and pancreatic cancer in India—the increase in gallbladder cancer being really alarming.¹² Studies have shown that chronic typhoid carrier state was the most important risk factor among patients with cancer of the gallbladder.¹³

The pattern of cancer mortality in some South-East Asian countries is shown in **Table 21.1**.

Prepathogenesis

Cancer originates as a single cell phenomenon. Factors responsible for carcinogenesis include irritation, embryonic rests, somatic mutation, extrachromosomal mutation, breakdown of immune defence mechanisms, hormonal alterations and viruses.

AGENTS FACTORS (CARCINOGENIC STIMULI)

A carcinogen is a substance or physical force which can change normal cells into neoplastic cells. Epithelial cells rarely undergo malignant change without such stimuli. Carcinogens are classified as chemical, physical, nutritional and biological and may be extrinsic as well as intrinsic.

Chemical carcinogens: Extrinsic carcinogens include the multitude of organic and inorganic chemical substances known to cause cancer. A large number of them belong to the aromatic series such as coal tar, asphalt, aniline dyes and benzidine. Sooth acted as carcinogen for scrotal cancer in chimney sweepers in London, as described by Sir Percivall Pott in the eighteenth century. Betel quid, tobacco, various brands of pan masala and the smoking of reversed cigar (chutta) induce cancer formation in the mouth.

TABLE 21.1: Pattern of cancer mortality in South-East Asian countries
(Figures refer to the percent of cancer at the site relative to total cancer mortality)⁶

Site	India		Japan		Sri Lanka		Thailand	
	M	F	M	F	M	F	M	F
Buccal cavity and pharynx	3.1	1.9	1.2	0.7	9.9	5.4	8.1	6.3
Esophagus	5.4	4.4	5.5	2.3	4.9	4.9	5.2	1.6
Stomach	9.4	6.4	43.7	35.9	14.3	19.9	7.4	5.0
Colon and rectum	8.9	5.7	6.6	8.4	4.8	2.6	6.3	5.7
Lung	9.4	3.1	11.8	5.7	2.9	2.1	8.3	5.1
Prostate	2.1	—	1.3	—	1.4	—	0.1	—
Breast	0.2	7.1	0.0	4.9	1.1	7.2	0.1	4.9
Uterus	—	12.1	—	11.4	—	10.6	—	15.3
Others	61.5	59.3	29.9	30.7	60.7	47.3	64.5	56.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Inorganic chemicals like nickel, arsenicals, asbestos and chromates are also well known carcinogens. Lime in betel is supposed to condition the oropharyngeal mucosa to the carcinogenic action of tobacco and areca.³

Carcinogens are found in insecticides, cosmetics and food additives also. The example of the latter are the various nonpermitted dyes used as coloring agents in food. Brominated vegetable oil (BVO), used in cold drinks as a stabilizing agent for cloudiness, is a known carcinogen whose use has been banned in most countries, including India.

Intrinsic carcinogens have not been studied as thoroughly as the extrinsic ones. The former include hormones and smegma. Hormones like estrogen and androgen play a possible role in breast, prostate, and endometrial cancers. Unwise and prolonged use of hormones such as estrogen and progesterone in contraceptive pills may cause cancer. Smegma is a well known carcinogen in the etiology of penile and cervical cancer. The incidence of this cancer is markedly low in circumcised males and their spouses. The prevalence rate of cervical cancer in Indian Muslims is half compared to that in the Hindus.⁶ The major risk factors associated with cervical cancer are early age at marriage and at first pregnancy, low economic status and multiparity. Other factors of importance are sexual promiscuity and cohabitation with uncircumcised male partners.³

Physical carcinogens: These may be in the forms of radiation energy and mechanical agents. *Radiations* include ultraviolet rays, corpuscular rays (alpha and beta), electronic rays (gamma-rays, X-rays) and heat radiation. Sufficient data linking radiation to development of various types of cancer are available. A steep rise in the incidence of leukemia in the West is attributed to increased diagnostic and therapeutic exposures. It is much higher in doctors, particularly radiologists, compared to the general public. The atom bomb tragedy in Nagasaki and Hiroshima in 1945 results in a crop of radioisotope induced malignancies, including leukemia. Continuous heat applied to skin can be carcinogenic as in the case of kangri cancer in Kashmir.

Mechanical agents such as chronic irritation and trauma do not usually initiate cancer formation but may promote carcinogenesis if an irritating carcinogen has produced its effect already; such as a projecting tooth in buccal mucosa, birth injuries in cervix and stones in gallbladder. Burn scars undergo malignant changes when exposed to constant friction. Dhoti cancer is a good example of cancer attributable to constant mechanical friction.³

Nutritional agents: More and more evidence is accumulating that nutritional factors play an important part in etiology of cancer. As far back as 1933, Ian Morrison Orr incriminated low dietary vitamin A intake in the etiology of oral cancer. Khanolkar was able to

demonstrate gross deficiency of thiamine and moderate deficiency of riboflavin in patients of oral cancer in the 1950's.³ Iron deficiency has been incriminated in the etiology of cancer; the Plummer-Vinson syndrome (sideropenic anemia with epithelial lesions) in rural North Sweden was known to be associated with cancer of upper alimentary tract. The syndrome and the cancer have both declined after the Swedish government started iron and vitamin fortification of flour.³ Dietary fibers has now emerged as a major factor associated with cancer of the bowel, a high fiber intake protecting against colonic carcinoma. On the other hand, a higher than optimal intake of energy and fats has been found to be associated with higher incidence of cancer of the breast and colon. In view of the association of diet with cancer and cardiovascular disease, Wynder has recommended the so called prudent diet providing 2500 to 2800 kilocalories per day, of which not more than 35 percent should come from fats, the presence of animal fat being so limited as not to provide more than 300 mg cholesterol.¹⁴

A recent study in Chennai observed that Indian women with cancer of the breast or of other sites might have low intake of green-yellow vegetables rich in fibre and carotenoids such as beta-carotene, zeaxanthin and lutein.¹⁵ Another case control study in Gujarat showed a protective effect of fibre for both oral submucous fibrosis and leukoplakia. Ascorbic acid was thought to be protective against leukoplakia as was consumption of tomato.¹⁶

Biological carcinogens: A large number of animal tumors are known to be caused by viruses. No human cancer has been definitely provided to be viral in etiology. However, there is strong evidence linking hepatitis B virus (HBV) with hepatocellular carcinoma and Epstein-Barr virus (EBV) with Burkitt's lymphoma. Besides viruses, *Schistosoma hematobium* infection is believed to be associated with bladder cancer.

Studies undertaken at the Institute of Cytology and Preventive Oncology (Delhi) indicate a significant role of Human Papillomavirus in the causation of cervical cancer. HPV is a sexually transmitted agent that infects the cells of the cervix and slowly causes cellular changes (dysplasia) that can result in cancer.⁸

HOST FACTORS

The diverse host factors, though very important, are not yet fully understood. These are described below.

Age: Relationship of age and cancer is interesting as well as bewildering. The known facts are summarized here.

- The most common general pattern is that of a marked increase in incidence of cancer with increase in age. This pattern is seen in general in case of carcinomas of skin, gastrointestinal tract and urinary tract, as well as in case of some nonepithelial cell cancers such as

chronic lymphatic leukemia and myelomatosis. The increased incidence with age probably reflects the result of longer exposure to environmental carcinogens. The rate of increase with age is very rapid and has been calculated to be proportional to the fourth, fifth or sixth power of the age. As an example, if the increase is proportional to the fifth power, then a cancer having an incidence of 1 per million at age 20 years will have an incidence of 1024 per million at 80 years of age.*

- A few tumors show a reverse pattern. A peak is seen in early life while the incidence is almost nil in later years. For example, nephroblastoma and retinoblastoma occur only in children, while teratomas and seminomas of the testis have peak incidence at 20 and 30 years respectively.
- Cancer of the uterine cervix starts appearing in adolescence. Its incidence increases with age up to menopause, followed by a steady decline thereafter. Breast cancer follows the same pattern in India.
- Hodgkin's disease appears in childhood and its incidence rate is rather constant thereafter, with slight peaks in young adult years and in old age.
- Some tumors do show a progressively increasing incidence with age, but the rate of increase is much slower than that mentioned in clause (a) above as applicable to carcinomas. The connective tissue sarcomas belong to this category.

Sex: Half a century ago, cancer all over the world was more common in women than in men but this was largely due to the high incidence of cervical cancer and low incidence of bronchial carcinoma. If one overlooks the cancer of sex specific organs (genital organs, breast, prostate) and cancer related to higher smoking in men, some sex differences in cancer incidence still stand out. Thus stomach carcinoma is always 1½ to 2 times more common in men. In Britain, lip cancer is 14 times and larynx cancer 7 times more common in men, while some cancers (gallbladder, thyroid and right side of colon) are up to two times more common in women.

Race: Racial differences in incidence of carcinoma have been clearly demonstrated by epidemiological studies. For example, fair skinned people have a grossly increased risk of developing squamous cell and basal cell carcinoma of the skin. On the other hand, the risk of chronic lymphatic leukemia and myelomatosis is less in the Chinese, Japanese and Indians.¹⁷ In India, distinct differences in pattern of cancer have been found

between Parsis and nonparsis in Mumbai.³ For example, incidence of cancer is about 100 per 100,000 in Parsi males and about 150 per 100,000 in nonparsis. Parsis are an exceptional community in the world where cancer incidence is more in females compared to males.

Heredity: Familial heredity definitely predisposes to certain types of cancer. It has been shown in general that as regards the common types of cancer, a sibling of an affected patient has twice the risk of developing cancer at the same site.¹⁷ It is, of course, likely that part of the increased risk is mediated through sharing similar environment and habits. More specific examples of genetic and hereditary determinants of carcinogenesis are as follows:

- Persons with blood group A have 20 percent higher risk of developing gastric cancer compared to those with B and O groups.¹⁷
- Polyposis coli (which is associated with a high risk of malignancy) is genetically determined as an autosomal dominant trait.
- Children with Down's syndrome have a higher risk of leukemia.
- Retinoblastoma has a high tendency to occur in sibs.

Habits and customs: Certain habits and customs are more conducive to cancer. Cancer of thigh and abdomen in Kashmir (Kangri cancer) is associated with the custom of using Kangri, a pot containing burning coals, to obtain heat in winter. The occurrence of oral cancer is associated with the custom of chewing a mixture of slaked lime, betel nut and tobacco. The habit of smoking is well known to lead to cancer of lung. The custom of circumcision in childhood is responsible for the lower incidence of cancer of penis and cervix among the Jews and Muslims.

Early marriage and sexual intercourse and multiparity increase the risk of cancer cervix which is a disease of married women above 35 years of age. Breast cancer, on the other hand, is a disease of aged spinsters.

ENVIRONMENTAL FACTORS

Both physical and socioeconomic environments may influence the occurrence of cancer. Skin cancer in farmers and sailors is associated with ultraviolet radiation depending upon the intensity and duration of exposure. Increase of ionizing radiations (gamma and X-rays) in the atmosphere may raise the incidence of leukemia and other cancers. Pollution of atmospheric air with smoke may be partly responsible for increased lung cancer incidence. Exposure to fibers of biogenic amorphous silica (BAS) formed from silica absorbed from the soil and deposited in the leaves of the sugar cane crop or crystalline silica formed as a result of conversion of BAS to cristobalite at high temperatures may account for the increased risks of lung cancer among sugar cane farmers.¹⁸ Bilharzial carcinoma of bladder in Egypt is related to the type of water supply. Some cancers are

* Note:

Incidence (I) at 20 years = 1×10^{-6}

$I = k \times \text{age}^5$ where k is a constant

$$k = \frac{I}{\text{age}^5} = \frac{1 \times 10^{-6}}{20^5}$$

Incidence at age 80 years = $K \times \text{age}^5 = \frac{(10^{-6})}{20^5} \times 80^5$
 $= 10^6 \times 4^5$, i.e. 1024 per million.

more common in low income groups, such as the cancers of esophagus, stomach, skin and cervix. The incidence of breast cancer is high and that of cervical cancer low in Parsi women because they marry late, produce less children and often marry within their own small groups.

Pathogenesis

The pathogenesis of cancer is the result of interaction between various agent, host and environmental factors. The period of pathogenesis may be divided into preclinical and clinical stages. The *preclinical stage* consists of a latent period of several years followed by a period of cancer *in situ* in which localized tissue changes are identifiable in the absence of symptoms. A good example is cervical cancer. Three *clinical stages* of cancer are:

1. Early stage when cancer is confined to the site of origin and the signs and symptoms are localized.
2. Stage of metastasis when secondary spread has occurred to organs remote from the primary site. This stage is often beyond the possibility of total cure.
3. Terminal stage when the disease is incurable and the patient succumbs to death. It is often accompanied by marked cachexia.

SURVIVAL RATES

Data on survival rates in some cancers have recently been available from some of the cancer registries in the country. The five-year survival rate for cancer of the cervix based on available data at the registries in Bangalore, Kerala and Chennai show that it varies between 34.4 and 47.4 percent. The survival rates are influenced by stage of disease on detection, status of treatment and socioeconomic status: Advanced disease, poor socioeconomic status and incomplete treatment have poorer survival.¹⁹⁻²¹

MEASURES OF PREVENTION

Cancer prevention ought to be undertaken as a public health program, especially in respect of those cancers that have high incidence and are preventable. Examples are oral cancer, lung cancer and cancer of the cervix and penis. More than 75 percent cancers are preventable by specific measures, including early treatment of precancerous conditions, and by removal of the cancer *in situ*. If cancer *in situ* is removed at a very early and asymptomatic stage, it may not recur. Delays in diagnosis and treatment are attributable to patients in 33 percent cases, doctors in 20 percent cases and both in 10 percent cases. The remaining 37 percent cases are attributed to vague clinical symptoms and to the latency of carcinogenesis.²² Preventive measures at various levels of intervention are described below.

Health promotion: This relates mainly to health education for early diagnosis. People should be motivated to change lifestyle patterns which predispose to cancers. Doctors can play a crucial role in providing such health education. Refresher and training courses for doctors should be organized for this purpose.

Specific protection: No specific protective measures comparable to vaccines in case of communicable diseases are available for prevention of cancer. However, several specific measures can be taken to eliminate the known carcinogenic factors in the agent, host or environment.

Agent factors:

- The use of known chemical carcinogens in industry should be modified or avoided if possible. Special caution is necessary as regards food additives, certain ingredients of modern cosmetics and several pesticides. Many chemicals used in these substances are known to be carcinogenic. Both public education and legal measures are necessary for this purpose.
- Undue exposure to harmful radiations should be avoided by the use of protective shields. Chronic mechanical irritation, trauma and thermal exposure should be avoided or reduced.
- Diet should be nutritionally adequate and well balanced.
- Smoking, tobacco chewing and the use of pan masalas should be avoided in view of their known carcinogenic effects.

Host factors: Detection or elimination of precancerous lesions is necessary. Systematic reevaluation and classification of precancerous lesions is helpful. Cervical carcinoma is amenable to diagnosis at the preinvasion or intraepithelial stage by cytological examination. Erosion, chronic infection and laceration of cervix should be treated early. Benign tumors of skin and other epithelial tissues may be potentially precancerous. Personal hygiene in relation to sex organs should be encouraged in view of the known association between circumcision, smegma and the cancer of penis and cervix. Circumcision may be considered a good custom from this point of view. Early and prolonged breastfeeding should be encouraged since it partly prevents against breast cancer.

Environmental factors: Many agent factors and some host factors listed above may be rightly regarded as environmental factors as well. For example, ionizing radiation, ultraviolet light and heat form a part of the physical environment. Industrial products, air and water pollutants, drugs, diet and food activities may be considered as part of chemical environment. Various infections associated with cancer may be regarded as forming the biological environment. Reproductive and sexual behavior and the use of tobacco pertain to social environment. Within this broad scope of environmental

factors, Doll and Peto have grouped them into 13 categories and calculated the relative importance of different environmental factors in terms of the proportion of cancer deaths attributable to each category in USA. According to them 30 percent cancer deaths are attributable to diet and tobacco each, thus accounting for almost two-thirds of all cancer deaths. The next two factors in degree of importance are infection (10%) and sexual and reproductive behavior (7%), followed by occupation (4%) and alcohol (3%). Out of the remaining 16 percent cancer deaths, one-third are attributable to diverse environmental factors (radiations, ultraviolet light, pollution, food additives, industrial products) while the rest are due to miscellaneous and unknown factors.²³

Early Diagnosis and Treatment

All persons should be instructed to self-examine themselves after the age of 30 and go to the specialist if the following warning signs are noticed.

- A lump or hard area in the breast or testes
- A change in a wart or mole
- A persistent change in digestive or bowel habits
- Persistent cough or hoarseness
- Excessive or irregular menstrual blood loss
- Blood loss from any natural orifice
- A swelling or sore that does not get better
- Unexplained loss of weight.

There should be cancer detection centers, with facilities to diagnose symptomless lesions and cancer *in situ*. Such facilities include:

- Clinical examination by experts.
- Exfoliative cytology, i.e. study of cells shed from the surface (such as bronchial, gastric or uterine mucosa) into secretion. The finding of malignant cells in body secretions helps in preclinical or early diagnosis. Pap test and cytopipette irrigation techniques detect cervical cancers at a stage when they are 100 percent curable.
- X-ray and ultrasound technique to diagnoses different cancers at different sites.
- Thermography test to find skin temperature elevation at the cancer site.
- Endoscopy such as bronchoscopy, colonoscopy, gastroscopy and proctosigmoidoscopy.

Mass screening of all men above 50 and women above 30, at least in selected groups, should be undertaken.

Early treatment depends upon early diagnosis. Cancer is a disease for which the first chance to cure is the best chance to cure. Almost all the skin cancers and 80 percent of the cervical cancers are curable if treated early. Treatment is done by surgery, radiotherapy and chemotherapy, as appropriate.

Recently a community-based intervention trial was carried out and its impact on oral cancers was

monitored. 59,894 subjects in intervention communities were compared with 54,707 subjects from nonintervention (control) communities. Subjects in the intervention communities received one round of screening for oral cancer by trained health workers and referral services from trained physicians, in addition to health education. The three-year (1995 to 1998) incidence rate of oral cancers was 20.3 per 100,000 person years in intervention communities compared with 56.1 in control communities. The three-year fatality rates were 56.3 percent in control group compared to 14.9 percent in intervention group. Results show that an intensive intervention program can drastically reduce the incidence and mortality from oral cancers.²⁴

Disability limitation and rehabilitation: An aspects of cancer management that is often neglected is pain relief. This is particularly important in advanced stage of cancer in patients diagnosed late. Pain can be controlled by appropriate analgesic therapy in 90 percent patients. Provision of suitable drugs for cancer pain relief may necessitate amendments in national drug legislation.²⁵ Rehabilitation may be physical, psychological or vocational. Physical aids may be necessary after amputation, laryngectomy, colostomy or face deforming surgery. The last may have to be performed for sarcoma of the jaw and carcinoma of maxillary antrum. Psychologically, the patient has to be prepared to accept willingly the change after operation. He has to be trained for a new vocation, if necessary, to remain a productive member of society according to his capacity.

Cervical Cancer

Cancer of the uterine cervix is the commonest cancer among Indian women. The incidence of cervical cancer in India is 1/5th of the world's total cases with 1,00,000 cases being diagnosed every year.²⁶ The age specific incidence rates for cervical cancer reveals that the disease increases from 35 years and reaches a peak between the ages 55 to 64 years. Approximately, 85 percent of women who die from cervical cancer belong to developing countries. According to National Cancer Registry Program of India, cancers of the uterine cervix and breast are the leading malignancies noted in Indian women.²⁷

EPIDEMIOLOGY

Cervical cancer is a major problem in India, as compared to the developed countries. Early age at marriage, high parity, low educational status, poor genital hygiene, multiple sexual partners are some of the risk factors for developing cervical cancer.

SCREENING METHODS²⁸

Cervical cancer is one type of cancer which can be detected early by sensitive screening methods. The conventional well established method is by PAP smear.

Beside the Pap smear, other alternative method like visual inspection has also been evaluated.

PAP smear: It is a cytological test that detects abnormal cervical cells. It is moderately sensitive test. Effective screening requires extensive infrastructural support—well trained cytotechnician, equipment, regular laboratory supply, linkages including transportation, reliable laboratory and well organized system for feed back for further diagnosis and treatment. At present this test is not feasible due to lack of resources.

Visual inspection methods for cancer screening:

This method is inferior to cervical cytology, but is more realistic in our present situation and is a low cost method. Four types of visual detection methods have been evaluated in India.

1. Unaided visual inspection or 'downstaging': It is not suitable as an independent screening test.
2. Visual inspection after application with acetic acid (VIA): It involves swabbing the cervix with 3 to 5 percent acetic acid solution prior to visual inspection. The results of the test are seen immediately. This is relatively simple, easy to carry out, does not require laboratory involvement and even paramedical workers can perform this test.
3. VIA using magnification devices (VIAM): Modification of VIA by using magnification devices.
4. Visual inspection after application of Lugol's iodine (VILI): Iodine based solution is added staining normal cervical cells brown, leaving the abnormal cells with a yellow or unstained appearance.

VIA, VIAM and VILI are suitable alternative screening tests to cytology for detecting cervical neoplasia in low resource settings.

HPV testing: HPV testing relies on molecular techniques that detect HPV DNA in cervical cell samples. There are two recognized techniques- (i) Signal amplified nucleic acid assay (HC II) and (ii) Target amplified HPV assay such as PCR. Both the technique requires transport of the sample to laboratory, storage and processing time in laboratory.

Health education and screening are of utmost important for prevention and treatment of cervical carcinoma. Guidelines have been laid down by an expert committee group for cervical cancer screening in India, where female health workers will be trained to screen for cancer cervix at primary health centre level by using VIA. Those women who are screened positive will be referred to the district hospital for PAP smear, colposcopy and further management.

VACCINES^{29,30}

Two vaccines namely Gardasil (Merck and co.) and Cervarix (Glaxo Smith Kline) are available for prevention of HPV infection and its sequelae like

cervical cancer, genital warts and anogenital cancers. Each vaccine includes HPV types 16 and 18, which account for approximately 70 percent of all cervical cancers worldwide. In addition, Gardasil contains HPV types 6 and 11, which are responsible for genital warts.

The HPV vaccine is licensed for use among women and girls in the age group of 9 to 26 years. Females should be vaccinated before their sexual debut because the vaccine is most effective in women who have not yet acquired HPV infection. Vaccine schedule requires three doses to be administered over a period of 6 months (Gardasil: 0, 2 and 6 months and Cervarix: 0, 1 and 6 months). Dose: This quadrivalent vaccine is given 0.5 ml intramuscularly in deltoid muscle. The vaccine is stored at +2 to +8°C and should be shaken well before use. The only barrier appears to be its high cost.

CANCER CONTROL AT NATIONAL LEVEL

At present more than 150 general hospitals, including medical college hospitals, offer facilities for cancer treatment by surgery, radiotherapy and chemotherapy. At the center there is a Cancer Control Board under the chairmanship of the Minister of Health and Family Welfare. Likewise, 15 states and union territories have also set up State Cancer Control Boards.³¹ The regional cancer centres have the following functions:

- Diagnosis, treatment and follow-up.
- Surveys of morbidity and mortality.
- Training of personnel, both medical and paramedical.
- Preventive measures with emphasis on mass examination, health education and industrial hygiene.
- Research, fundamental and applied.

Primary health centers and small hospitals can refer cancer patients to teaching and large general hospitals. If necessary, the patients may be further referred from here to the regional cancer centers.

A major drawback in India is the lack of information on cancer. Such information can be generated only by means of population-based registries. The first population-based registry in India, the Indian Cancer Registry, was established in Bombay in 1964. In 1992, the ICMR started the National Cancer registry Project (NCRP). Eleven cancer registries have now been established under the National Cancer Registry Program. The current network consists of six population-based registries at Mumbai, Bangalore, Chennai, Bhopal and Barshi (rural-Maharashtra) and five hospital-based registries at Thiruvananthapuram, Dibrugarh, Mumbai, Bangalore and Chennai registries. The Mumbai, Bangalore and Chennai registries have both a hospital as well as a population-based registry.⁸

The NCRP has the following objectives:

- Generation of authentic incidence data in defined areas.
- In-depth epidemiological investigations through case control studies on site-specific cancers.

- Intervention programs in population-based registry areas.
- Assistance for regional research and treatment centers: 17 Regional Cancer Research and Treatment Centers are recognized by the Government and each is provided a recurrent expenditure of Rs 75 lakhs per year. The Regional Cancer Centers are located at Bangalore, Ahmedabad, Gwalior, Chennai, Tiruvananthapuram, Cuttack, Guwahati, Kolkata, New Delhi, Mumbai, Allahabad, Hyderabad, Nagpur, Patna, Bikaner, Shimla and Rohtak. The functions of the Regional Cancer Centers are:
 - Cancer diagnosis, treatment and follow-up
 - Surveys of cancer mortality and morbidity
 - Training of medical and paramedical personnel
 - Preventive measures with emphasis on screening, health education and industrial hygiene
 - Research (fundamental and applied).

National Cancer Control Program (NCCP)

National Cancer Control Program was started in the year 1975 to 76. At that time priority was given to equip premier cancer institutions in the country. For this central assistance @ Rs 2.5 lakh per institution was provided, especially to purchase cobalt machines. In 1984, the strategy was revised and stress was laid on primary prevention and early detection of cancer cases.

In 1990 to 91, District Cancer Control Programme was initiated in selected districts in the country. Districts were selected based on their proximity to medical colleges.

A modified District Cancer Control Programme has been initiated in 2000 to 2001.

GOALS AND OBJECTIVES OF NCCP (REVISED STRATEGY)

- Primary prevention of cancer by health education regarding hazards of tobacco consumption and necessity of genital hygiene for prevention of cervical cancer.
- Secondary prevention—early detection of cancers by screening methods and patient education on self-examination methods.
- Strengthening of existing cancer treatment facilities.
- Palliative care in terminal stage cancer.

SCHEMES UNDER NCCP

- Development of Oncology Wings in Govt. Medical College Hospitals—Central assistance of Rs. 2.00 crores per institution is being provided for more than 30 medical college hospitals for purchase of equipment including cobalt machines.
- District Cancer Control Scheme: A scheme for district projects regarding prevention, health education, early detection and pain relief measures was started in 1990. A one time grant of Rs 15 lakhs is provided for each district project and a recurring grant of Rs 15 lakhs is provided for each district project and a recurring grant of Rs 10 lakh per year for 4 years. The districts are linked with institutions capable of providing treatment. 50 districts have been provided with funds till now.
- Financial assistance to voluntary organizations: More than 30 voluntary agencies recommended by the State Governments have been provided an assistance of up to Rs 5 lakhs each for undertaking health education and early detection activities.
- Cobalt therapy installation: Financial assistance for setting up cobalt therapy units is provided both to charitable as well as government hospitals.
- Assistance for mammography unit: Selected institutions are being supported for setting up mammography units.

MODIFIED DISTRICT CANCER CONTROL PROGRAM

This was launched in 2000 to 2001 in the States of Bihar, West Bengal, Tamil Nadu and Uttar Pradesh covering a female population of 15 lakhs. The project is envisaged to find out the awareness amongst women aged 20 to 65 years about cancer, health facilities available to women and health education. The project is likely to be completed by 2002.³²

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Cardiovascular Diseases

Cardiovascular diseases constitute the leading cause of death in men in economically developed countries. In women, it is the second or third leading cause. In several countries in the west, cardiovascular diseases account for half of the total mortality.¹ Heart disease has been labelled as the single largest killer of the world. Twelve million persons die annually worldwide due to diseases of heart and arteries. Fifty percent of these deaths are preventable. Also, 50 percent of these deaths occur in the developing countries. 40 million persons in India are estimated to be suffering from cardiovascular disease.² CVS death rate per lakh population in India in 1985 for males and females was 146 and 126 respectively. These figures were projected to be 253 and 204 respectively in 2000 and 295 and 239 in 2015.²

The following cardiovascular diseases will be discussed here: ischemic heart disease, rheumatic heart disease, essential hypertension and cor pulmonale.

Ischemic Heart Disease (IHD)

It is also commonly known as coronary heart disease and coronary artery disease, because most cases of myocardial ischemia are due to involvement of the coronary arteries. Hospital prevalence of IHD in India was reported to be 6 to 23 percent while community prevalence was reported to be 6.5 percent and 4.8 percent in urban men and women and 2.3 percent and 1.7 percent in rural men and women respectively.³ These figures include silent as well as clinically apparent cases of IHD. In a more recent study from Delhi, the prevalence of coronary heart disease in adult aged 25 to 64 years was found to be 31.9 per thousand in men and 25.3 per thousand in women. It may be mentioned that this disease was virtually unknown in premenopausal Indian women till about three decades ago. At that time the M:F ratio was 13:1 in US whites and about 1:1 in US blacks. The increased female prevalence observed during recent decades is primarily attributable to changing lifestyles, especially as regards female smoking.

It ought to be mentioned that a lot still needs to be known about the nature of coronary disease. Even the claim that there has been a recent epidemic of coronary artery disease has been disputed.⁴

Many of the risk factors for IHD are well established. The highest risk group has more than 10 times the risk compared to that in the lowest risk group.⁵ The various risk factors are listed below.

- Factors not amenable to preventive measures:
 - Increasing age
 - Male sex
 - Family history of premature IHD.
- Factors which can be minimised by preventive measures:

Diet: IHD has been found to be positively associated with intake of saturated fats and sucrose and to be negatively associated with intake of dietary fibers. Positive association with intake of animal protein and coffee has been reported but not confirmed.

Lipid metabolism: Serum cholesterol levels are positively associated with IHD. It has been found that while hypercholesterolemia is a risk factor for IHD, an even better correlation of IHD is found with serum LDL cholesterol (cholesterol present as a component of low density lipoproteins). During recent years, it has been found that HDL cholesterol is, in fact, inversely related to IHD (**Table 21.2**).

Other constitutional factors: These include hypertension, carbohydrate intolerance and obesity. Recent evidence suggests that hemostatic factors resulting in

TABLE 21.2: Relation between HDL cholesterol and ischemic heart disease (Data from the Framingham study)⁵

HDL cholesterol level (mg/100 ml)	Incidence rate per 1000 population at risk
Below 25	176.5
25 to 34	100.0
35 to 44	104.5
55 to 64	51.0
65 to 74	59.7
65 to 74	25.0
75 and above	0

hypercoagulability of blood (high plasma levels of factor VII, factor VIII and fibrinogen) are also associated with IHD.⁵

Physical inactivity: Epidemiological studies⁶ have shown a clear inverse relation between vigorous exercise and IHD. It has been found that exercise reaching maximal energy output level may be more beneficial than overall total energy output at low intensity of effort.⁵ Vigorous exercise may be regarded as one involving an energy expenditure of 5 kcal/minute or more.

Smoking: Heavy smokers have three-fold risk of IHD compared to nonsmokers.

Socioeconomic factors: IHD is more common in the upper socioeconomic classes.

Psychological stress: Stressful situations predispose to IHD. For example, it has been found that widowers have a higher mortality from IHD during the six months after the death of the wife compared to married men of similar age. Also, persons with type 'A' or 'Coronary prone' behavior pattern have been shown to have more than twice the risk of developing IHD compared to those without it.⁵ It may be mentioned that the type A individual is described as an aggressive, striding, ambitious and restless person bothered with deadlines. Those without such pattern are labelled as type B.

Water hardness: Studies in England have shown that IHD occurs less in those areas where water is hard. Such water tends to have a higher content of nitrate, carbonate, calcium and silica.

Alcohol: Heavy drinking is associated with high IHD mortality, but moderate drinking (upto three drinks per day) has been shown to protect against IHD in the West.⁵ However, such protective effect may be related to the fact that alcohol intake raises serum HDL cholesterol. Also, moderate drinking may relieve mental stress, thereby lowering the risk of IHD related to stress.

Two generalizations need to be made about the risk factors of coronary disease. Firstly, the role of genetic factors has yet to be fully appreciated. It is the genetic code that determines which patient will get the disease and who will respond to which treatment.⁷ Secondly,

environmental factors play as yet unclear role. A 16-year follow-up study of two identical cohorts revealed 46 coronary deaths in the control group compared to 67 in the group where various coronary risk factors were modified effectively.⁸ However, 54 percent of the reported decline in coronary deaths in USA during 1968 to 1976 has been attributed to changes in lifestyle. It may be mentioned that the extent of decline attributable to coronary artery bypass surgery was only 3.5 percent.⁹

Rheumatic Fever (RF) and Rheumatic Heart Disease (RHD)

Acute Rheumatic fever is predominantly a disease of children aged 5 to 14 years and generally does not affect children less than 3 years old or adults. However, people can have recurrent episodes well into their forties. The prevalence of RHD peaks in the third and fourth decades.^{10,11}

In the 2004 WHO Technical Report it was estimated that worldwide, there were 5.5 deaths per 100,000 population in 2000.¹² In 2005, it was estimated that over 2.4 million children aged 5 to 14 years are affected with RHD and 79 percent of all RHD cases come from less developed countries. Further, the annual number of new ARF cases in children aged 5 to 14 years was more than 336,000. Similar to RHD, 95 percent of cases come from less developed countries.¹³ From there, they estimated that of all cases of ARF, 60 percent would go on to develop RHD each year.

In India, prevalence figures over the past five years have been derived almost entirely from school surveys. Between 1940 and 1983, the prevalence rate for RHD varied from 1.8 to 11 per 1000 (national average 6 per 1000), while between 1984 and 1995 the rate varied from 1 to 5.4 per 1000. During the same periods of time, the prevalence of rheumatic fever ranged from 0.06 to 5.01 and 0.32 to 0.54 per 1000, respectively.¹⁴ In the south Indian population, Vellore in Tamil Nadu had a 0.3 percent prevalence of RHD during 1982 to 90, which declined to 0.068 percent during 2001 to 02. The incidence estimates are predominantly in north Indian population. It ranges from 0.17 to 0.75 per 1000 population.¹⁵ In the year 2000 in Kanpur the incidence was estimated as 0.750 per 1000 population in a sample size of 3963 among 7 to 15 years of age group.¹⁶ Because of the different methods of collecting the data it is not possible to be certain that these figures represent a fall in the prevalence of RHD. By comparison, in western countries the prevalence of RHD in children aged between 5 and 15 years is below 0.5 per 1000, and for rheumatic fever it is below 1 per 1000.¹⁴

Rheumatic heart disease is the most significant sequelae of Rheumatic Fever. Although the exact causal pathway is unknown it seems that some strains of group A *Streptococcus* are "rheumatogenic" and that a small proportion of people in any population (3-5%) have

an inherent susceptibility to acute rheumatic fever (ARF).¹⁰ Acute rheumatic fever (ARF) is an autoimmune consequence of infection with group A streptococci. It causes an acute generalized inflammatory response and an illness that selectively affects the heart, joints, brain and skin. Despite the dramatic nature of an acute episode, ARF leaves no lasting damage to the brain, joints or skin. However, damage to the heart valves, particularly the mitral and aortic valves, may persist after an acute episode has resolved. This involvement of the cardiac valves is known as rheumatic heart disease. People who have had ARF previously are much more likely to have subsequent episodes, and these recurrences may cause further damage to the cardiac valves. Thus RHD steadily worsens in people who have multiple episodes of ARF.¹¹

Group A streptococci can be subdivided into more than 70 distinct types on the basis of M protein. Certain types of group A streptococci (including M types 1, 3, 5, 6, 14, 18, 19, 24, 27, and 29) appear to be more frequently, but not exclusively, associated with rheumatic fever. The M type refers to the M protein of the cell wall or the opacity factor antigens produced by the strain.¹⁷

Joint involvement is the most common manifestation of RF. In an ICMR survey of school children aged 5 to 15 years, RHD patients had a history of polyarthrititis in 18 percent cases, migrating polyarthralgia in 26 percent cases and chorea in 3 percent cases.¹⁸ In cases of first attacks of acute rheumatic fever, the following frequency of various signs and symptoms was reported:

Polyarthralgia	50 percent
Polyarthrititis	36 percent
Carditis	14 percent
Corea	4 percent
Subcutaneous nodules	0.9 percent

History of sore throat 1 to 5 weeks earlier is present in about two-thirds cases of rheumatic fever. Such sore throat is caused by group A hemolytic streptococci. Prevention of RHD after an attack of rheumatic fever depends to a large extent upon long-term prophylactic use of penicillin. This is because of the fact that each subsequent attack of rheumatic fever increases the risk of cardiac damage. One attack of rheumatic fever, in fact, raises manifolds the risk of subsequent attack.

Girls and women in particular seem to be severely affected, possibly as a result of being housebound and having to live in overcrowded conditions. Overpopulation, overcrowding, poverty, and poor access to medical care are undoubtedly the main reasons for the high prevalence of RHD in India. Another reason may be the inadequate use of penicillin by general practitioners because of fears over allergic reactions.

The WHO¹⁷ has recently issued guidelines for diagnosis of rheumatic fever. These are reproduced in **Table 21.3** and are essentially based upon the Jones criteria revised in 1982 and approved by the American

TABLE 21.3: Criteria for diagnosis of rheumatic fever

Major manifestations	Minor manifestations
Carditis	<i>Clinical</i>
Polyarthrititis	Fever
Chorea	Arthralgia
Erythema marginatum	Previous rheumatic fever or rheumatic heart disease
Subcutaneous nodules	<i>Laboratory</i>
	Acute phase reactions:
	Abnormal erythrocyte sedimentation rate
	C-reactive protein
	Leukocytosis
	Prolonged P-R interval.

The presence of two major, or one major and two minor, manifestation plus evidence of a preceding streptococcal infection indicates a high probability of rheumatic fever. Previous infection is indicated by: increased antistreptolysin O or other streptococcal antibody; positive throat culture for group A *Streptococcus* and recent scarlet fever. Manifestations with a long latent period, such as chorea and late onset carditis, are exempted from this last requirement.

Heart Association. The WHO recommended that strict adherence to the criteria mentioned in **Table 21.3** can be waived in the following three instances:

- Insidious or late onset carditis
- Chorea
- Rheumatic recurrence.

In the above 3 categories, the diagnosis of rheumatic fever can be accepted even when two major (or one major and two minor) manifestations are not present. In the first two, however, the requirement for a prior streptococcal infection can also be waived.

Primordial and Primary Prevention

Primordial prevention generally requires significant improvements in the social determinants of health such as improvement in housing, hygiene infrastructure and access to health care.

Primary prevention is defined as the adequate antibiotic therapy of group A streptococcal upper respiratory tract infection.¹² Primary prevention is administered only when there is group A streptococcal upper respiratory tract infection. Primary prevention has been shown to be effective in reducing the frequency of subsequent cases of RF, however has not to date been proven to be cost-effective, resulting in secondary prophylaxis remaining the mainstay of RF/RHD management.¹⁹

ANTIBIOTIC TREATMENT OF ACUTE RHEUMATIC FEVER¹¹

There is general consistency in the literature that the acute RF should be treated with intramuscular benzathine benzylpenicillin. However there is some debate about at what weight the dose should increase from 600,000 IU

to the adult does of 900,000 IU. With the accepted oral alternative being phenoxymethylpenicillin or erythromycin if the patient has a penicillin allergy.

The WHO Essential Medicines List for Children (EMLc), first written in 2007, and the WHO Model Formulary, latest edition released in 2008, have the following medications and dose regimens listed for the management of rheumatic fever (RF) and/or rheumatic heart disease (RHD).

BENZATHINE HENZYLPENICILLIN

Powder for injection:

900 mg (=1.2 million IU) in 5 ml vial

1.44 g (= 2.4 million IU) in 5 ml vial.

Streptococcal pharyngitis; primary prophylaxis of rheumatic fever, *by deep intramuscular injection*, adult and child over 30 kg, 900 mg as a single dose; child under 30 kg, 450 to 675 mg as a single dose.

Secondary prophylaxis of rheumatic fever, *by deep intramuscular injection*, adult and child over 30 kg, 900 mg once every 3 to 4 weeks; child under 30 kg, 450 mg once every 3 to 4 weeks.

PHENOXYMETHYLPENICILLIN

Powder for oral liquid: 250 mg (as potassium salt)/5 ml,

Tablet: 250 mg (as potassium salt)

For secondary prophylaxis of rheumatic fever, by mouth, 1 to 5 years: 125 mg twice daily; 6 to 12 years: 250 mg twice daily.

ERYTHROMYCIN

Capsule or tablet: 250 mg (as stearate or ethyl succinate), Powder for oral liquid: 125 mg (as stearate or ethyl succinate). No specific dose has been mentioned in model formulary.

Secondary Prophylaxis (Prevention)

Secondary prevention of rheumatic fever (RF) is defined as the continuous administration of specific antibiotics to patients with a previous attack of RF, or a well-documented rheumatic heart disease. The purpose is to prevent colonization or infection of the upper respiratory tract (URT) with group A beta-hemolytic streptococci and the development of recurrent attacks of RF.¹² This secondary prophylaxis has been shown to be both effective and cost-effective at the community/population level with high prevalence of RHD.¹¹

In the 2004 WHO Technical Report on RF and RHD, IM injection of benzathine benzylpenicillin every three weeks (every four weeks in low-risk areas or low-risk patients) is outlined as the most effective strategy for prevention of recurrent attacks of RF. They cite oral penicillin as a possible alternative, but raise the concern

TABLE 21.4: Antibiotics used in secondary prophylaxis of RF from WHO Technical Report on RF and RHD 2004¹²

Antibiotic	Mode of administration	Dose
Benzathine benzylpenicillin	Single IM injection every 3 to 4 weeks	≥ 30 kg: 1.2 million units < 30 kg: 600,000 units
Penicillin V	Oral	250 mg twice daily
Sulfonamide (e.g. sulfadiazine, sulfasoxazole)	Oral	≥ 30 kg: 1 g daily < 30 kg: 500 mg daily
Erythromycin	Oral	250 mg twice daily

of noncompliance to a daily routine over many years. For those allergic to penicillin, oral sulfadiazine or oral sulfasoxazole were considered optimal second choices. Oral erythromycin was reserved for those patients allergic to both penicillin and sulfa drugs (**Table 21.4**).¹²

DURATION OF PROPHYLAXIS¹¹

- For 5 years after the last attack of AEF or until 18 years of age (whichever is longer)
- If carditis present, for 10 years after last attack, or at least until 25 (whichever is longer)
- If more severe valvular disease or after valve surgery, lifelong.

Hypertension

Hypertension is the leading cause of cardiovascular disease worldwide. Prior to 1990, population data suggest that hypertension prevalence was decreasing; however, recent data suggest that it is again on the rise. In 1999 to 2002, 28.6 percent of the US population had hypertension. Hypertension prevalence has also been increasing in other countries, and an estimated 972 million people in the world are suffering from this problem. Incidence rates of hypertension range between 3 percent and 18 percent, depending on the age, gender, ethnicity, and body size of the population studied.²⁰

In India, one study in rural areas of Haryana (1994-95) demonstrated 4.5 percent prevalence of hypertension (JNC V criteria) while urban areas of Delhi had a higher prevalence of 45 percent during 1996 to 97.² In the ICMR study in 1994 involving 5537 individuals (3050 urban residents and 2487 rural residents) demonstrated 25 percent and 29 percent prevalence of hypertension (Criteria: ≥ 140/90 mm of Hg) among males and females respectively in urban Delhi and 13 percent and 10 percent in rural Haryana.²² Further, Gupta R from Jaipur, through three serial epidemiological studies (Criteria: ≥ 140/90 mm of Hg) carried out during 1994, 2001 and 2003 demonstrated rising prevalence of hypertension (30%, 36%, and 51% respectively among males and 34%, 38% and 51% among females). In 2002, Hazarika, et al reported 61 percent prevalence

(criteria: JNC VI) among man and women aged thirty and above in Assam. The Sentinel Surveillance Project 102, documented 28 percent overall prevalence of hypertension (criteria: JNC VI) from 10 regions of the country in the age group 20 to 69.¹⁵

Hypertension is an under-diagnosed condition because it causes damage to the body with no symptoms or only mild symptoms. It has been called a “silent killer” for this reason. Correct diagnosis of the cause of high blood pressure is important. Most cases of chronic hypertension are “primary hypertension” but a small percentage is “secondary hypertension” where the rise in blood pressure is caused by another underlying condition. Hypertension during pregnancy is another common special case; it is called gestational hypertension, preeclampsia or eclampsia depending on its severity.

DEFINITION

High blood pressure, according to the WHO-ISH guidelines, includes both hypertension (defined as 140/90 mm Hg or above) and “high normal” (between 130/85 mm Hg and 140/90 mm Hg). The guidelines acknowledge that high normal blood pressure also poses a threat to health.²³

The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) Report defines blood pressure as:²⁴ **Table 21.5.**

CRITICISM OF JNC DEFINITION²⁵

- Subjects who have been identified as hypertensive because of taking antihypertensive medication seems to be in the no mans’ land in JNC 7 criteria, unless they have been placed in a separate category.
- In JNC definition, the term ‘antihypertensive medication’ creates the confusion. The persons who are effectively controlled their BP by nonpharmacological measures, where they should be placed? However this anomaly will be replaced if the JNC opts to replace ‘medication’ by ‘measures’.
- The phrase ‘antihypertensive medication’ creates another glitch. Drugs from which system of medicine constitute antihypertensive medication has not been specified, since a number of indigenous/alternative systems claimed to have a good control of BP.

TABLE 21.5: Classification of blood pressure

Blood Pressure classification	Systolic Blood Pressure (SBP) mm Hg	Diastolic Blood Pressure (DBP) mm Hg
Normal	<120	<80
Prehypertension	120 to 139	80 to 89
Stage I Hypertension	140 to 159	90 to 99
Stage II Hypertension	≥160	≥100

HYPERTENSION IN CHILDREN AND ADOLESCENTS

Hypertension in children and adolescents continues to be defined as systolic BP (SBP) and/or diastolic BP (DBP) that is, on repeated measurement, at or above the 95th percentile.²⁶ BP between the 90th and 95th percentile in childhood had been designated “high normal.” To be consistent with the *Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure* (JNC 7), this level of BP will now be termed “prehypertensive” and is an indication for lifestyle modifications.²⁴

DILEMMA OF ADOLESCENT HYPERTENSION

WHO has classified adolescent age group as 10 to 19 years.²⁷ Paradoxically during classification of adolescent hypertension, WHO has considered 10 to 18 years as adolescent and 18 years and above as adult and has given hypertension criteria separately. Here lies the contradiction! According to WHO, ‘18 years age group’ is an adolescent by definition, but considered as adult during classification of hypertension.²⁸

BLOOD PRESSURE MEASUREMENT²⁴

The auscultatory method with a properly calibrated and validated instrument should be used. Persons should be seated quietly for at least 5 minutes in a chair (rather than on an exam table), with feet on the floor, and arm supported at heart level. Measurement of BP in the standing position is indicated periodically, especially in those at risk for postural hypotension. An appropriate-sized cuff (cuff bladder encircling at least 80 percent of the arm) should be used to ensure accuracy. At least two measurements should be made. SBP is the point at which the first of two or more sounds is heard (phase 1), and DBP is the point before the disappearance of sounds (phase 5).

TYPES OF HYPERTENSION

Primary hypertension: It is the main type with no underlying cause. Its prevalence is 93 to 95 percent.

Secondary hypertension: Hypertension is caused by some other underlying condition; much less common than primary hypertension.

Renal causes:

- **Renoparenchymal:** Acute and chronic glomerulonephritis, chronic pyelonephritis, analgesic nephropathy, polycystic kidney disease, gout with renal failure, vasculitis and obstructive nephropathy, etc.
- **Renovascular:** The most common cause of renovascular hypertension in India is Takayasu’s syndrome (progressive aortoarteritis). Other causes being atherosclerotic renovascular disease, atherosclerotic disease (most common causes of

renovascular disease in western population), fibromuscular dysplasia, etc.

Endocrine causes: Pheochromocytoma, primary aldosteronism, Cushing's syndrome, etc.

Oral contraceptives:

Miscellaneous: Coarctation of aorta, both hypothyroidism and hyperthyroidism, sleep apnea syndrome, acute stressful situations, drugs like glucocorticoids, etc.

HYPERTENSION DURING PREGNANCY

Gestational hypertension: Early stages of high blood pressure during pregnancy.

Pre-eclampsia: Severe high blood pressure during pregnancy; occurs about 5 percent of pregnancies.

Eclampsia: Very severe pregnancy hypertension leading to seizures.

Pulmonary hypertension: Hypertension occurring in the heart-lung arteries.

Malignant hypertension: Occurring in younger adults than the normal profile for essential hypertension

Resistant hypertension: Resistant hypertension is the failure to reach goal BP in patients who are adhering to full doses of an appropriate three-drug regimen that includes a diuretic.

Agent Factors

Physical agents: Hypertension is less common in people living at high altitude.²⁹

Chemical agents: Intake of alcohol, tobacco, caffeine, steroid hormones and soft water³⁰ is associated with hypertension. The main nutritional agent associated with hypertension is salt or sodium chloride. Epidemiological surveys have brought out two seemingly conflicting facts:

- Hypertension is less common in populations that consume less salt and blood pressure does not rise with age in such populations.
- Within same population, there is not relation between salt intake or excretion and hypertension. It may be mentioned that since salt intake is difficult to measure, salt excretion is often used as an estimate of salt intake. Recent observations suggest that subjects with essential hypertension have a genetically determined defect in extrusion of sodium from red blood cells and in renal excretion of sodium.³¹

Host Factors

Age, sex and race: Blood pressure rises with age especially after 40 years. Sex and race differences, if any, are not inherent but environmental. In India, M:F ratio varies from 3:1 to 2:1.

Heredity: It is polygenic in inheritance. If both parents are normotensive, 3 percent children develop hypertension. If one parent is hypertensive, 28 percent,

and if both parents are hypertensive, 44 percent of the children develop hypertension. It has been found that close relatives of a person with systolic blood pressure 50 mm above population mean have themselves a blood pressure 17 mm above population mean.³⁰

Body build: Blood pressure is four times more prevalent in obese and bulky persons. Blood pressure falls with reduction in weight.

Personality and psychological state: There is enough evidence that worry and mental conflict are associated with high blood pressure.

Environmental Factors

Environment plays a major role in essential hypertension. Social environment entailing struggle for job, competition, loss of job, difficulties at home and workplace, death in the family, etc. induce mental stress and strain leading to increase in blood pressure. Stressful environment is more common in urban life, in industry and in upper socioeconomic groups.

Prevention and Control

Complications of hypertension or target organ damage:³²

(i) Stroke, transient ischemic attack, dementia, carotid bruits, (ii) Left ventricular hypertrophy or left ventricular strain on electrocardiogram, (iii) Heart failure, (iv) Myocardial infarct, angina, coronary artery bypass graft, or angioplasty, (v) Peripheral vascular disease, (vi) Fundal hemorrhages or exudates, papilledema, (vii) Proteinuria, (viii) Renal impairment (raised serum creatinine).

White Coat syndrome

White Coat syndrome is a well-documented syndrome thought to be responsible for up to 20 to 50 percent of patients newly diagnosed with hypertension. It is defined as a hypertensive blood pressure in the office but a normal blood pressure with either home or ambulatory monitoring. In these persons the appearance of the sphygmomanometer or care provider is thought to give rise to stress or a conditioned fear response that causes an increase in blood pressure. In some cases, such a blood pressure response may persist for years despite familiarity with medical staff and multiple BP readings. A recommended solution for this phenomenon is the use of home blood pressure monitoring. Ambulatory blood pressure monitoring (ABPM) provides information about BP during daily activities and sleep. ABPM is warranted for evaluation of "white-coat" hypertension in the absence of target organ injury.³³ If the ambulatory blood pressures during waking hours average less than 132/83 mm Hg, but the patient's blood pressure spikes when measured in the office, current recommendations, although controversial, are to refrain from treatment with medication.

TREATMENT OF HYPERTENSION

Lifestyle Measures³²

Major lifestyle modifications shown to lower BP include weight reduction in those individuals who are overweight or obese, adoption of the Dietary Approaches to Stop Hypertension (DASH) eating plan³⁴ which is rich in potassium and calcium, dietary sodium reduction, physical activity, and moderation of alcohol consumption.

- Maintain normal weight for adults (body mass index 20 to 25 kg/m²).
- Reduce salt intake to < 100 mmol/day (< 6 g NaCl or <2.4 g Na⁺/day).
- Limit alcohol consumption to £ 3 units/day for men and £ 2 units/day for women.
- Engage in regular aerobic physical exercise (brisk walking rather than weightlifting) for ≥ 30 minutes per day, ideally on most of days of the week but at least on three days of the week.
- Consume at least five portions/day of fresh fruit and vegetables.
- Reduce the intake of total and saturated fat.

Drug Therapy

The drug or formulation used should ideally be effective for 24 hours when taken as a single daily dose. An interval of at least four weeks should be allowed to observe the full response, unless it is necessary to lower blood pressure more urgently. The drug dose (except for thiazides or thiazide-like diuretics, the ideal dose of which is uncertain) should be titrated up according to situations.³²

Surgical Therapy

A revolutionary new operation, which will take 1 hour, could effectively cure high blood pressure has been developed by scientists. The new procedure, called renal sympathetic-nerve ablation, involves inserting a wire into a blood vessel close to the kidneys to burn through nerves which carry signals that stimulate high blood pressure. It disrupts signals from the brain telling the kidneys to keep blood pressure raised. This is still in research phase.

Cor Pulmonale

Cor pulmonale or pulmonary heart disease has been defined by WHO as the hypertrophy of right ventricle resulting from disease affecting pulmonary structure or function. It was found in 28.8 percent of autopsies performed on patients dying of cardiac disease in Delhi.³⁵ According to hospital statistics, the percentage of cardiac patients diagnosed to have cor pulmonale

varied from 3.5 percent in Vellore to 31.6 percent in Jaipur and was 16.6 in Delhi. The incidence is higher in Northern India because of higher frequency of respiratory infections, severe winter and the common practice of living in ill-ventilated houses with inadequate outlet for smoke. Sexes are equally affected. Peak incidence is found after fifth decade in men and before fifth decade (between 31 and 50 years) in women. According to a study by Padmavati in Delhi in 1984, cor pulmonale was found to be due to the following causes:

Bronchiectasis	47.5 percent
Chronic bronchitis	41.9 percent
Bronchial asthma	3.5 percent
Pulmonary tuberculosis	4.5 percent

PILOT PROJECT ON CONTROL OF CARDIOVASCULAR DISEASES AND STROKE

A pilot project was initiated by Govt. of India in 1995 to 96. It is planned to start a program in the organized sectors like railways, CGHS, industry, etc. by carrying out health check-ups for early detection. Some IEC material has also been developed. Control efforts for cardiovascular diseases, stroke and diabetes mellitus are being integrated and a project for Integrated Noncommunicable Disease Control is being developed.³⁶

WHO STEPS³⁷

Introduction

The WHO STEP wise approach to surveillance (STEPS) is the WHO's recommended tool for surveillance of chronic diseases (noncommunicable disease) and their risk factors.

It provides an entry point for low and middle income countries to get started on chronic disease surveillance activities. It is also designed to help countries build and strengthen their capacity to conduct surveillance.

Rationale for Surveillance of Chronic Disease Risk Factors

Chronic, noncommunicable diseases are responsible for 60% of all deaths globally. Especially in developing countries, the burden of chronic diseases is increasing rapidly and will have significant social, economic, and health consequences.

The main chronic diseases attributable to the most common risk factors are:

- Heart disease
- Stroke
- Cancer
- Chronic respiratory diseases
- Diabetes

TABLE 21.6: Levels of the STEPS instrument

Step	Description	Purpose	Recommendation
1	Gathering demographic and behavioral information by questionnaire in a household setting.	To obtain core data on: <ul style="list-style-type: none"> • socio-demographic information • tobacco and alcohol use • nutritional status • physical activity. 	All countries/sites should undertake the core items of Step 1.
2	Physical measurements in a household setting.	To build on the core data in Step 1 and determine the proportion of adults that: <ul style="list-style-type: none"> • are overweight and obese • have raised blood pressure. 	Most countries/sites should undertake Step 2.
3	Taking blood samples in a clinic.	To measure prevalence of diabetes or raised blood glucose and abnormal blood lipids.	Only recommended for well-resourced settings.

The WHO Geneva STEPS team and the WHO Regional Office provide guidance and support for STEPS Surveillance

For STEPS surveillance, the term ‘chronic diseases’ is used because it emphasizes the following important shared features:

- The epidemics take decades to become fully established—they have their origin at young ages.
- They require a long-term systematic approach to treatment.
- Given their long duration, there are multiple opportunities for prevention.
- Health services must integrate the response to these diseases with the response to infectious diseases.

Objectives of surveillance of chronic disease risk factors and selected chronic diseases:

- Collect consistent data across and within countries.
- Develop standardized tools to enable comparisons over time and across countries/sites.
- Prevent chronic disease epidemics before they occur.
- Help health services plan and determine public health priorities.
- Predict future caseloads of chronic diseases.
- Monitor and evaluate population-wide interventions.

Basis of STEPS

STEPS is a sequential process. It starts with gathering key information on risk factors with a questionnaire, then moves to simple physical measurements and then to more complex collection of blood samples for biochemical analysis.

STEPS emphasizes that small amounts of good quality data are more valuable than large amounts of poor data. It is based on the following two key premises:

- Collection of standardized data
- Flexibility for use in a variety of country situations and settings.

Population Focus

STEPS uses a representative sample of the study population. This allows for results to be generalized to the population.

STEPS Instrument

The STEPS tool used to collect data and measure chronic disease risk factors is called the STEPS instrument.

It is of 2 types – Chronic disease risk factor surveillance and stroke surveillance.

The STEPS instrument covers three different levels, or ‘Steps’, of risk factor assessment: Step 1, Step 2 and Step 3, as follows (**Table 21.6**).

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Obesity

The global epidemic of overweight and obesity - "globesity" - is rapidly becoming a major public health problem in many parts of the world. Paradoxically coexisting with undernutrition in developing countries, the increasing prevalence of overweight and obesity is associated with many diseases. Overall, the obesity epidemic results in a substantial decrease in quality of life and life expectancy and it accounts for heavy expenditure in provision of health care. In many developing countries, the progression of nutritional transition has been detected, characterized by a reduction of prevalence of nutritional deficiencies and more occurrence of overweight and obesity. Due to difficulty in treatment of obesity in adults and many long term adverse effects of childhood obesity, prevention of childhood obesity in the form of primordial prevention has now been recognized as a public health priority.¹

The urban cities in the country are facing high prevalence of obesity. In 2000, a multi centric study involving seven urban cities (Chennai, Bangalore, Hyderabad, Mumbai, Calcutta and New Delhi) in India among the age group of 20-40 and ≥ 40 age group showed a prevalence of 31% and 38% respectively.²

Risk Factors for Developing Overweight and Obesity³⁻⁶

- Poor knowledge of healthy food habits.
- Changes in Life Style (Urbanization)
 - Unhealthy eating patterns like low consumption of fruits, green leafy vegetables and milk.
 - Wrong choices of food, increased portions of high glycemic index foods.
 - Increased oil consumption
 - Snacks, colas (junk food)
- Sedentary habits due to long school hours, tuitions etc.
- Reduced physical activity due to increased vehicles, reduced play areas, TV, telephones.
- Genetic/Constitutional predisposition.
- Skipping of breakfast.
- Intergenerational effects - gestational diabetes.

Assessing Health Risks Associated with Overweight and Obesity⁷

BMI is just one indicator of potential health risks associated with being overweight or obese. For assessing someone's likelihood of developing overweight- or

TABLE 21.7: The International Classification of adult underweight, overweight and obesity according to BMI

Classification	BMI(kg/m ²)	
	Principal cut-off points	Additional cut-off points
Underweight	<18.50	<18.50
Severe thinness	<16.00	<16.00
Moderate thinness	16.00 - 16.99	16.00 - 16.99
Mild thinness	17.00 - 18.49	17.00 - 18.49
Normal range	18.50 - 24.99	18.50 - 24.99
	23.00 - 24.99	
Overweight	≥ 25.00	≥ 25.00
Pre-obese	25.00 - 29.99	25.00 - 27.49
	27.50 - 29.99	
Obese	≥ 30.00	≥ 30.00
Obese class I	30.00 - 34.99	30.00 - 32.49
	32.50 - 34.99	
Obese class II	35.00 - 39.99	35.00 - 37.49
	37.50 - 39.99	
Obese class III	≥ 40.00	≥ 40.00

Source: Adapted from WHO, 1995, WHO, 2000 and WHO 2004.

obesity-related diseases, the National Heart, Lung, and Blood Institute guidelines recommend looking at two other predictors:

1. The individual's waist circumference (because abdominal fat is a predictor of risk for obesity-related diseases) and waist hip ratio (WHR).
2. Other risk factors the individual has for diseases and conditions associated with obesity (for example, high blood pressure or physical inactivity).

Another criterion of obesity is skinfold thickness measured by skinfold calipers. The most commonly measured is triceps skinfold along with biceps, sub scapular and supra-iliac.

BMI Classification

Body Mass Index (BMI) is a simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in meters (kg/m²) **Table 21.7**.

In identifying the age and gender specific cut-off points of BMI for the age range of 1 – 18 years: Children with ≥ 85th percentiles were considered overweight, those with ≥ 95th percentiles were obese, while those with < 85th percentiles were considered desirable or lean.

BMI values are age-independent and the same for both sexes. However, BMI may not correspond to the same degree of fatness in different populations due, in part, to different body proportions. The health risks associated with increasing BMI are continuous and the interpretation of BMI gradings in relation to risk may differ for different populations.

In recent years, there was a growing debate on whether there are possible needs for developing

different BMI cut-off points for different ethnic groups due to the increasing evidence that the associations between BMI, percentage of body fat, and body fat distribution differ across populations and therefore, the health risks increase below the cut-off point of 25 kg/m² that defines overweight in the current WHO classification.

There had been two previous attempts to interpret the BMI cut-offs in Asian and Pacific populations,^{8,9} which contributed to the growing debates. Therefore, to shed the light on this debates, WHO convened the Expert Consultation on BMI in Asian populations (Singapore, 8-11 July, 2002).⁵ But body composition and metabolism of Indians (Asians in general) make them especially prone to 'adiposity' (fat content in the body) and its consequences. South Asians have at least 3 to 5% higher body fat for the same BMI as compared to Caucasians. The fat is typically located 'centrally' (i.e. waist, trunk) and around visceral organs - metabolically more dangerous than peripheral fat.

But the cut-off points of 23, 27.5, 32.5 and 37.5 kg/m² are to be added as points for public health action. It was, therefore, recommended that countries should use all categories (i.e. 18.5, 23, 25, 27.5, 30, 32.5 kg/m², and in many populations, 35, 37.5, and 40 kg/m²) for reporting purposes, with a view to facilitating international comparisons.¹⁰

Elizabeth health path for adults and adolescents is a novel and easy chart, which is ideal for screening adolescents for risk of overweight.

Complications

Obesity has physical, psychological, and social consequences in adults and children. These are: (i) Development of diet-related chronic diseases including diabetes mellitus, cardiovascular disease, stroke, hypertension, dyslipidemia (high total cholesterol or high levels of triglycerides), (ii) It affects self esteem and has negative consequences on the cognitive and social development, (iii) Osteoarthritis (degeneration of cartilage and underlying bone within a joint), (iv) Certain cancers (endometrial, breast, and colon), (v) Liver and gallbladder disease, (vi) Sleep apnea and respiratory problems, (vii) Gynecological problems (abnormal menses, infertility).

As per the new 2005 International Diabetes Federation definition 3, the criteria for the diagnosis of the metabolic syndrome are:

- Central obesity + any two of the following four factors
- Raised serum triglycerides: > 150 mg/dl
 - Reduced serum HDL cholesterol: < 45 mg/dl
 - Raised blood pressure (BP systolic > 130 and diastolic > 85 mm Hg)
 - Raised fasting blood sugar level: > 100 mg/dl

Prevention and control

Modification of eating habits may be singleton tactic strategy for appropriate weight control, along with change in sedentary habits, lifestyle and regular physical activity by means of health education.

Developing Innovative Partnerships⁷

CDC is making progress in halting the obesity epidemic through innovative partnerships.

- *The Healthy Eating Active Living Convergence Partnership (CP)* seeks to foster policy and environmental change through innovative partnerships with others from fields not traditionally involved in public health.
- *Common Community Measures for Obesity Prevention (Measures Project)* fills two crucial gaps hindering obesity efforts—the absence of standard measures for community-level policy and environmental change initiatives and a tool for monitoring these initiatives.
- *Early Assessment of Programs and Policies to Prevent Childhood Obesity* is identifying a set of promising local programs and policies and determining which ones merit rigorous evaluation.
- *Addressing Obesity through Commercial Health Plans.* CDC is working to help public health professionals and health care plan administrators collaborate to improve obesity interventions designed for medical settings.

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Diabetes

Recent estimates indicate there were 171 million people in the world with diabetes in the year 2000 and this is projected to increase to 366 million by 2030.¹ At present, India is considered as the diabetic capital of the world by WHO.² There are approximately 3.5 crore diabetics in India, and this figure is expected to increase up to 5.2 crore by 2025. Every fifth patient visiting a consulting physician is a diabetic and every seventh patient visiting a family physician is a diabetic.³ By the year 2025 it is predicted that India will have a rise of 59 percent of diabetics in the population— which is the highest number of diabetic patients in the world.⁴

Prevalence T2DM increased in urban Indian adults from < 3% in 1975 to > 12% in the year 2000.⁵ Gupta R from Jaipur, through three epidemiological studies carried out during 1994, 2001 and 2003 demonstrated rising trend rates of diabetes (criteria: FBS > 126 mg/dl or history) 1 percent, 13 percent, and 18 percent respectively among males and 1 percent, 11 percent and 14 percent respectively among females.⁶

Diabetes is a condition primarily defined by the level of hyperglycaemia giving rise to risk of microvascular damage (retinopathy, nephropathy and neuropathy). It is associated with reduced life expectancy, significant morbidity due to specific diabetes related microvascular complications, increased risk of macrovascular complications (ischemic heart disease, stroke and peripheral vascular disease), and diminished quality of life.

Classification of Diabetes Mellitus

TYPE 1 DIABETES

This type is immune-mediated in over 90 percent of cases and idiopathic in less than 10 percent. The rate of pancreatic β cell destruction is rapid in some individuals and slow in others. It may occur at any age but most commonly arises in children and young adults with a peak incidence before school entry and again at around puberty. Exogenous insulin is required since circulating insulin is virtually absent.

- Polyuria, polydipsia, and weight loss.
- Plasma glucose of 126 mg/dl or higher after an overnight fast, documented on more than one occasion.
- Presence of ketonemia, ketonuria or both and presence of islet autoantibodies.

TYPE 2 DIABETES

This type predominantly occurs in adults, but also observed in children and adolescents. Insulin resistance is seen in presence of sufficient circulating endogenous insulin.

TABLE 21.8: This table summarizes the 2006 WHO recommendations for the diagnostic criteria for diabetes and intermediate hyperglycaemia¹

<i>Diabetes</i>	
Fasting plasma glucose 2-h plasma glucose*	≥ 7.0 mmol/l (126 mg/dl) or ≥ 11.1 mmol/l (200 mg/dl)
<i>Impaired Glucose Tolerance (IGT)</i>	
Fasting plasma glucose 2-h plasma glucose*	< 7.0 mmol/l (126 mg/dl) and ≥ 7.8 and < 11.1 mmol/l (140 mg/dl and 200 mg/dl)
<i>Impaired Fasting Glucose (IFG)</i>	
Fasting plasma glucose 2-h plasma glucose*	6.1 to 6.9 mmol/l (110 mg/dl to 125 mg/dl) and (if measured) <7.8 mmol/l (140 mg/dl)

* Venous plasma glucose 2-h after ingestion of 75 g oral glucose load

* If 2-h plasma glucose is not measured, status is uncertain as diabetes or IGT cannot be excluded

- Polyuria and polydipsia.
- Plasma glucose of 126 mg/dl or higher after an overnight fast on more than one occasion. After 75 g oral glucose, diagnostic values are 200 mg/dl or more 2 hours after the oral glucose.
- Hypertension, dyslipidemia, and atherosclerosis are often associated.

Diagnostic Tests Used to Define Glycemic Status (Table 21.8)

Venous plasma glucose: This is the standard method for measuring and reporting. However, in recognition of the widespread use of capillary sampling, especially in under-resourced countries, conversion values for capillary plasma glucose are provided for post-load glucose values. For some reasons the conversion of whole blood glucose to plasma glucose is problematic and the previously published WHO conversion tables may be inaccurate in some situations. Venous and capillary samples will give the same result in the fasting state but in the nonfasting state capillary will give higher results than venous samples.

Glucose should be measured immediately after collection by near patient testing, or if a blood sample is collected, plasma should be immediately separated, or the sample should be collected into a container with glycolytic inhibitors (e.g. NaF) and placed on ice-water until separated prior to analysis.

Oral glucose tolerance test (OGTT): There is continuing debate about the place of the oral glucose tolerance test (OGTT) for clinical and epidemiological purposes. The test is recommended by the WHO. Although ADA acknowledges the OGTT as a valid

way to diagnose diabetes, the use of the test for diagnostic purposes in clinical practice is discouraged in favor of fasting plasma glucose for several reasons, including inconvenience, greater cost and less reproducibility.

The OGTT should be retained as a diagnostic test for the following reasons:

- Fasting plasma glucose alone fails to diagnose approximately 30 percent of cases of previously undiagnosed diabetes.
- An OGTT is the only means of identifying people with IGT.
- An OGTT is frequently needed to confirm or exclude an abnormality of glucose tolerance in asymptomatic people.

An OGTT should be used in individuals with fasting plasma glucose 6.1 to 6.9 mmol/l (110 to 125 mg/dl) to determine glucose tolerance status.

Glycated hemoglobin (HbA1c): HbA1c reflects average plasma glucose over the previous 2 to 3 months in a single measure which can be performed at any time of the day and does not require any special preparation such as fasting. These properties have made it the gold standard for assessing glycemic control in people with diabetes and have resulted in its consideration as an option for assessing glucose tolerance in people without diagnosed diabetes. Currently HbA1c is not considered a suitable diagnostic test for diabetes or intermediate hyperglycemia.

In November 2005 a joint WHO and International Diabetes Federation (IDF) Technical Advisory Group met in Geneva to review and update the current WHO guidelines.

Prevention and Control

- **Diet:** A well-balanced, nutritious diet remains a fundamental element of therapy. The American Diabetes Association (ADA) recommends about 45 to 65 percent of total daily calories in the form of carbohydrates; 25 to 35 percent in the form of fat (of which less than 7% are from saturated fat), and 10 to 35 percent in the form of protein. In patients with type 2 diabetes, limiting the carbohydrate intake and substituting some of the calories with monounsaturated fats, such as olive oil, rapeseed (canola) oil, or the oils in nuts and avocados, can lower triglycerides and increase HDL cholesterol. The current recommendations for both types of diabetes continue to limit cholesterol to 300 mg daily, and individuals with LDL cholesterol more than 100 mg/dl should limit dietary cholesterol to 200 mg daily. High protein intake may precipitate renal disease in patients with diabetic nephropathy; for these individuals, a reduction in protein intake to 0.8 kg/

day (or about 10% of total calories daily) is advised. Dietary fiber tends to retard nutrient absorption rates so that glucose absorption is slower and hyperglycemia may be slightly diminished. High soluble fiber content in the diet may also have a favorable effect on blood cholesterol.⁷

- **Drug:** Hypoglycemic drugs and insulin are used.
- **Exercise:** For weight reduction. Behavior modification to achieve adherence to the diet, as well as increased physical activity to expend energy are required.

National Diabetes Control Program

The National Diabetes Control Program was started on a pilot basis during the Seventh Five Year Plan in some districts of Tamil Nadu, Jammu and Kashmir and Karnataka, but, due to paucity of funds in subsequent years this program could not expand further.

The five objectives of the program are:

1. Primary prevention by identifying high risk subjects at an early stage and imparting appropriate risk reducing health education to them, their family and community by IEC program.
2. Secondary prevention through early diagnosis and appropriate treatment of the disease to reduce morbidity and mortality with special reference to groups at risk.
3. Prevention of acute metabolic and chronic cardiovascular, renal and ocular complications of the disease.
4. Provision of equal opportunities for physical attainment and scholastic achievement for the diabetic patients; and
5. Rehabilitation of those particularly or totally physically handicapped due to the disease.

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Accidents

Accidents constitute an important cause of preventable morbidity, mortality and disability. In case of 58 countries for which data were available with the WHO, mean mortality rate due to accidents, poisoning and violence was found to be 64 per 1,00,000 population.¹ These causes accounted for 5 to 10 percent of all deaths in the majority of these countries. Accidents constitute the first leading cause of death for the age group 5 to 45 years in developing as well as developed countries and the third leading cause at all ages. However, the accident deaths form a lesser proportion of total deaths in the lesser developed countries because of a larger number of deaths due to infection and malnutrition, etc.¹ Such proportion is often less than 10 percent of the age group 5 to 14 years in developing countries, compared to over 40 percent for boys and over 30 percent for girls in highly industrialized countries. The classification of accidents according to the International Classification of Diseases is given below.

- Motor vehicle accidents
- Suicide and self-inflicted injury
- Accidental falls
- Accidents mainly of industrial type
- Accidental drowning and submersion
- Accidental poisoning
- Accidents caused by fires, etc.
- All other accidents.

Motor accidents and suicide are two major causes of accidental deaths. Data from 54 countries reveal the annual figures to be 173,000 deaths due to motor accidents and 120,000 due to suicide. Assuming 30 percent underreporting for suicide, it can be safely stated that the mortality from suicide is on the same scale as that from motor vehicle accidents.¹

Motor Accidents

Road accidents are emerging as a major cause of death in most countries. A case study from Delhi brings out the facts vividly. According to the data from Delhi Traffic Police² the number of vehicles in Delhi increased three and a half times during 1982 to 1990, resulting in a sharp increase in accidents and fatalities (**Table 21.9**). According to a study by the Central Road Research Institute, the major factors for increase in road deaths are:

TABLE 21.9: Road accident trends in Delhi

	1982	1988	1989	1990
No. of vehicles (In lakhs)				
Motor vehicles	6.45	14.16	15.90	18.30
Slow moving	4.63	14.41	16.30	19.06
% increase in accidents over previous year	11.25	7.7	7.08	7.02

(i) Rapid increase in personalized modes of transport, (ii) A mixture of slow and fast vehicles and, (iii) A lack of road discipline. Added to the above three is the contributing factor of a large number of two wheelers in Delhi the largest for any city in the world. The two wheelers are a peculiarly dangerous mode of transport because of the size and balance factors. The risk of accident related death is five times higher in two wheelers riders compared to car drivers. A study conducted by the Indian Institute of Technology, Delhi, found the number of crash deaths per million passenger kilometers to be 16.8, 7.8, 3.5 and 3.4 for two wheelers, three wheelers, cars and buses, respectively.

Safety measures: More than 10,000 persons can be saved every year in India by following road safety precautions.³ Some of these precaution are as follows.

- **Use of helmet:** Use of helmet by two wheeler riders is compulsory as per the Motor Vehicles Act. However, transport being a state subject, only a few states have notified the use of helmet as a compulsory measure. It is unfortunate that in spite of the proven benefit of the helmet in prevention of head and neck injury, its use is subject to political considerations. For example, notifications regarding the use of helmet already issued in Kerala, Andhra Pradesh, Karnataka and Tamil Nadu, were withdrawn with the change in ruling party in the state. In Australia, even the cyclists have to use a helmet.

The three desirable attributes in a good helmet are as follows:

1. It should cover as much of face area as possible.
 2. Its thermocol padding should be at least 22 mm thick.
 3. It should be yellow or orange, these being the two most visible colors. Visibility can be further enhanced by putting reflective strips on the back and sides of the helmet.
- **Use of scooter lights during day time:** Keeping scooter headlights on during the day enhances visibility of the scooter and thus reduces the risk of accident.
 - **Use of proper glass in wind screen:** Indian vehicles use toughened glass in the wind shield. The use of such glass is banned in the West. Toughened glass stores energy during an accident and transfers it to the head as soon as the person hits it. Hence, the glass causes more damage.

All cars in the West are now fitted with laminated wind shield. This has a plastic layer between the glass sheets. When it shatters, the glass sticks to the plastic which does not allow the head to pass through. This has proved to be the single most affective measure.

- **Pneumatic bus doors:** More than half of the road deaths are due to fall from moving buses.

Pneumatic doors which close before the bus starts can go a long way in preventing fatal road accidents.

- **Curb parking:** Studies have shown that too many vehicles parked on the road is a risk factor for accidents as drivers are not able to see pedestrians crossing across the road from behind the parked vehicles. Proper parking is therefore an important preventive measure.³
 - **Drinking and driving:** Education of people and strict action by police to control drunken driving is extremely important to reduce unwanted deaths on the roads.
7. **Use of low beam headlights:** In India most people drive at high speed with high beam lights. These lights blind and dazzle the person coming in the opposite direction and can cause accidents.
 8. Use mobile phones while driving has been established as a contributory factor for vehicle accidents.

Accident and Trauma Services

In view of the increasing morbidity and mortality due to accidents, a model accident and trauma service was proposed to be initiated in Delhi with the following objectives:

- Providing prompt services to injured person right from the site of the accident.
- Preventing number of deaths and extensive disabilities.
- Training medical and paramedical personnel in first aid resuscitation and treatment.
- Establishing zonal peripheral centers and apex center with all essential facilities for trauma care and appropriate networking.

A modest beginning was made in procuring ambulances fitted with essential equipment and strengthening of tertiary care hospitals in Delhi. A comprehensive accident and trauma service for the National Capital is planned.⁴

Haddons Matrix^{5,6} (Table 21.10)

It is a framework for analyzing injury based on the host (i.e. the person injured), the agent (i.e. what caused the injury, e.g. electrical energy) and the environment (i.e. the physical and social context in which the injury occurred).

Analyzing injury in this way helps to develop a three tiered approach to approach to injury prevention which includes behavioral, environmental and policy changes. Haddon's Matrix is used to assess injury and methods of prevention.

Suicide

Challenges to the health of children have been changing in the recent decades. Childhood diseases causing significant mortality and morbidity in the past few decades have now been tackled through immunization

TABLE 21.10: Haddons matrix

Phase	Host	Vehicle	Physical environment	Social environment
Pre-event	Driver ability, driver training	Maintenance of brakes, vehicle inspection programs, installation of child restraint, child restraint checking programs	Adequate roadway markings, correct installation of child restraint, right child restraint for child's height and weight	Attitudes to drink driving/speed/use of child restraints for every car trip
Event	Human tolerances to crash forces, wearing of seatbelt, having child in a correctly fitting child restraint	Crash worthiness of the vehicle (e.g. crush space), crash worthiness of child restraint (e.g. head extrusion)	Presence of fixed object near roadway, presence of unsecured object within the vehicle	Enforcement of mandatory seatbelt and child restraint use
Post-event	Crash victims general health status	Petrol tanks designed to minimize likelihood of post crash fire	Availability of effective and timely emergency response	Public support for trauma care and rehabilitation

and child health programs. However, new challenges threatening child health are emerging. Child abuse and neglect is one of them. Child abuse is an emotional, physical, economic and sexual maltreatment meted out to a person below the age of eighteen.⁷ The Centers for Disease Control and Prevention (CDC) define child maltreatment as any act or series of acts of commission or omission by a parent or other caregiver that results in harm, potential for harm, or threat of harm to a child.⁸ Most incidents of child abuse occur in a child's home, but instances of abuse occurring in school or the community with whom the child interacts with are also not uncommon.

Worldwide about 40 million children under the age of 14 years are estimated to suffer from abuse and neglect.⁹ One of the most important long-term consequences of childhood abuse is suicidal behavior in adolescence.¹⁰ Adolescents and young adults with a history of childhood maltreatment were 3 times more likely to become depressed or suicidal compared with individuals without such a history.¹¹ Physical abuse and neglect by parents is found as one of the main reason for suicidal behavior among Indian adolescents.¹²

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Blindness

Blindness is now a major public health problem both in the developed and the developing countries. A blindness prevalence rate of more than 1 percent is widely acknowledged as indicative of a significant public health problem.¹ The past few decades have seen an upsurge in the number of the blind. This is due to increase in total population and increase in life expectancy resulting in increase in geriatric population. It is well known that the aged suffer 20 to 100 times more from blindness compared to children.

Definition

No standard definitions existed earlier for defining the magnitude. The WHO in 1979 defined categories of visual impairment² as a first step to obtain comparable data (**Table 21.11**).

TABLE 21.11: Categories of visual impairment and blindness³

Category	Visual acuity (with both eyes, using best possible correction)
1	Below 6.18 to 6/60 to 3/60 or more
2	Below 6/60 to 3/60 or more
3	Below 3/60 to 1/60 or more (Finger counting at 1 M)
4	Below 1/60 to Light perception alone
5	No light perception
6	Undetermined or unspecified.

The WHO recommends that categories 3,4 and 5 should be labeled as blind while categories 1 and 2 denote visual impairment. Thus, for international comparisons, a cut-off point of 3/60 is important. It should also be noted that although visual loss is defined primarily in terms of distant visual acuity, account should also be taken, wherever possible, of visual field and near vision. For visual field comparisons, patients with field of vision less than 10° but more than 5° around central fixation should be placed in category 3 while those with a field loss of less than 5° should be placed in category 4 even if the central acuity is not impaired.² Though there is a need for an internationally acceptable definition for comparing populations, each country must endeavor to define blindness in relation to its own social and economic conditions.

The National Program for Control of Blindness in India defines blindness in the following manner.

Vision < 6/18-6/60 in better eye	: Low vision
Vision < 6/60-3/60 in the better eye	: Economic blindness
Vision < 3/60 in the better eye	: Social blindness

Thus the Indian definition basically consider anybody whose earning potential (economic blindness) is impaired as blind while the WHO considers anybody who is not able to lead a normal social life (social blindness) as blind. The two terms are therefore called ‘Work Vision’ and ‘Walk Vision’ to differentiate between the Indian and the WHO definition.

Global Magnitude

It must be appreciated that there is a paucity of reliable and accurate data on blindness. It must also be remembered that because of variation of blindness criteria, most available figures are not strictly comparable.

Early five seconds one individual goes blind (<3/60) somewhere in the world. Globally, the WHO estimates that in 2000 AD, there were nearly 45 million blind people (< 3/60) and 135 million with low vision (< 6/18-6/60 in better eye). Therefore 180 million people around the world have some degree of visual disability. Cataract is the main cause of blindness worldwide with an estimated 16 million being cataract blind. It is estimated by the WHO that nearly 7 million newly blind are added every year of whom 70 percent have their vision restored by treatment. The number of blind people is therefore increasing by 2 to 3 million every year. Without intensified efforts, the prevalence of blindness is likely to double by 2020 AD.³

The prevalence in the developing countries is 10 to 40 times higher as compared to the developed countries.

On a global scale, the causes of blindness are as shown in **Table 21.12**.

The major cause of blindness in the Western World is age-related macular dgeneration which accounts for 25 to 50 percent of adult blindness. Glaucoma, cataract

and diabetic retinopathy are the other major causes, each being responsible for approximately 10 to 20 percent of blindness.

In developing countries, cataract is responsible for 40 to 70 percent of all blindness and glaucoma for 10 percent. Onchocerciasis is seen exclusively in Africa and South America and trachoma in tropical regions. In children, genetic factors are the major cause of blindness in the west, while xerophthalmia and measles are responsible for more than 50 percent of childhood blindness in Asia and Africa.⁴

The prevalence of blindness in different geographical regions is given in **Table 21.13**.

Magnitude in India

The first comprehensive survey was undertaken by ICMR in 1971 to 74. This survey projected that 9 million were economically blind in the country. Of these 3.14 million had visual acuity of 3.60 or less. The major causes of blindness in this survey are shown in **Table 21.14**.

This survey showed that cataract had emerged as the major cause of blindness in the country while corneal causes accounted for about 25 percent.⁵ The most recent survey was carried out by NPCB and SHO over the period 1986 to 89. This survey showed that there

TABLE 21.12: Causes of blindness—worldwide

Cause	No blind (Millions)	Geographical distribution
Cataract	16.0	Universal
Trachoma	6.0	Poor, hot, dry areas
Glaucoma	5.5	Open angle-Africa; Angle closure-South-East Asia
Xerophthalmia	0.5	Asia, Africa
Onchocerciasis	0.5	Africa, Latin America
Age related macular degeneration	1.0	Developed countries
Diabetic retinopathy	0.25	Developed countries
Leprosy	0.25	Asia, Africa
Others	2.50	Universal

Source: Ref 3 (slightly modified)

TABLE 21.13: Prevalence of blindness and estimated blind population

Region	Population (millions)	Prevalence of blindness (%)	Blind population (millions)
Asia	2800	0.8	20.0
Africa	550	1.0	6.0
Latin America	400	0.5	2.0
Europe/USSR/Oceania	700	0.2	1.5
North America	260	0.2	0.5

TABLE 21.14: Causes of blindness—ICMR (1971–74)

Causes	Percentage of total blindness
Cataract	55.0
Vitamin A deficiency	2.0
Trachoma	5.0
Glaucoma	0.5
Smallpox	3.0
Injuries	1.5
Other infections	15.0
Other causes	18.0

TABLE 21.15: Causes of blindness and visual impairment in the WHO NPCB survey 1986–89.

Causes	Percentage of blind
Cataract	81.0
Refractive errors	7.0
Corneal opacities	3.0
Glaucoma	2.0
Trachoma	0.2
Vitamin A deficiency	0.04
Others	7.0

TABLE 21.16: Various categories of states in India

Category	Prevalence (%)	States
Low	< 1	Punjab, HP, Delhi, West Bengal, North Eastern States
Moderate	1 to 49	Gujarat, Haryana, Kerala, Bihar, Karnataka, Andhra Pradesh, Assam
High	1.5 to 1.9	Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh
Very high	≥ 2	Madhya Pradesh, Rajasthan, J and K

was an increase in the blind population in India. The cut-off point was taken as 6/60 and it was seen that there were 12 million blind in both eyes and another 8 million in one eye. The causes enumerated in this survey are shown in **Table 21.15**.

The major factors responsible for high prevalence of blindness in India are follows:

- Increase in population
- Increased life expectancy
- Poor access to eye care facilities
- Under utilization of available ophthalmic manpower
- Compromised nutritional status of mothers, infants and children
- Lack of awareness regarding eye health
- Environmental factors predisposing to high infection rates.

Based on the 1986 to 89 survey, the States in India have been categories as follows **Table 21.16**:

A pilot survey was undertaken in two districts in the country in 1999. This was done in Sivagana district (Tamil Nadu) and Bharatpur district (Rajasthan). The cause of blindness among 50 + population were as follows:

Cataract	55 percent
Uncorrect refractive error	19 percent
Glaucoma	4 percent
Corneal pathology	7 percent
Other causes	15 percent

Major Blinding Disorders

Experience from several developing countries has demonstrated that 2/3 or more of existing blindness is avoidable, i.e. either preventable (as in the case of trachoma and vitamin A deficiency) or curable (as restoration of sight in cataract and refractive errors).

The main blinding diseases have specific epidemiological characteristics which, if properly assessed, may increase effectiveness of intervention strategies.

Cataract

Surveys in a number of countries suggest that almost half of the world's blind are those having unoperated cataract. Surveys in Nepal, Saudi Arabia, India, China, Thailand, Sri Lanka and Vietnam confirm cataract as being responsible for 40 to 80 percent of blindness.⁶

Age: Cataract is usually diagnosed after the age of 60 to 70 years in most of the developed countries. In developing countries, the onset is much earlier, usually after the age of 40 years. In India, cataracts are 3 times more common and develop earlier in life compared to USA.

Sex: Women are more commonly affected but men have been observed to be 1.6 times more likely to have undergone cataract extraction.

Socioeconomic status: Those from lower socioeconomic state have a higher incidence. This could be related to poor nutritional status, use of cheap fuel sources and extensive exposure to sunlight, all of which are important determinants for cataract. Similarly, low literacy levels also predispose to increased risk of cataract. The literacy effect may also be due to other underlying socioeconomic factors.

Exposure to sunlight: Ultraviolet radiation above 295 nm has been postulated to be cataractogenic. This is a component of sunlight. Population-based studies in USA, Australia and Nepal provide evidence for the role of sunlight in cataract formation. In Nepal, sites exposed to an average of 12 hours of sunlight had 3.8 times as much cataract as sites exposed to only 7 hours of sun.⁸

Other factors: Diabetes, cigarette smoking, dehydrational crisis and the type of fuel used for cooking have all been hypothesised to be important determinants. However, no conclusive evidence has yet been presented.

Nutritional Blindness

Xerophthalmia is a major cause of blindness in the preschool age group (0 to 5 years) and is commonly associated with malnutrition. Twenty-three countries in the world have the highest risk of vitamin A deficiency. India, Bangladesh, Indonesia, Nepal, Sri Lanka, Vietnam and the Philippines have a public health problem in the Asian region. Cross-sectional prevalence surveys in Asia indicate that 0.4 percent of the preschool children suffer from nutritional blindness.

Corneal involvement leading to blindness is seen only in the preschool age group. Though night blindness and Bitot's spots occur more frequently in males, the incidence of active corneal lesions is similar in both sexes. Nutritional blindness is mostly aggregated in lower socioeconomic strata. Concurrent infection with measles increases the risk of nutritional blindness. Disasters, whether natural or man made, also increase the risk. Early withdrawal from the breast and late supplementation are related to deficiency states.

Glaucoma

This disease may manifest in several forms but mainly as angle closure glaucoma with sudden intense pain and rapid loss of vision or open angle glaucoma as a chronic insidious disease with slow but progressive loss of visual fields. Both forms are age related, occurring predominantly after the age of 40 years. The classical presentation is a triad consisting of elevated intraocular pressure, characteristic optic disc changes and visual field losses.

In India, prevalence of glaucoma has been reported to vary from 4.4 to 7.2 percent of population above 35 years of age. The ratio of open angle glaucoma to angle closure glaucoma in India is now thought to be almost equal.

Trachoma

Worldwide, trachoma is the most common cause of preventable blindness. Trachoma and associated infections are estimated to affect 400 to 500 million in the world, of whom approximately 2 million get blind. Blinding trachoma is no longer seen in the west. Presently, blinding trachoma is endemic in most of North Africa and the Eastern Mediterranean region and in parts of Asia, East and West Africa and Latin America.

Blinding trachoma is a disease of rural areas, urban slums and shanty towns where environmental sanitation is poor, overcrowding is rampant and personal hygiene is poor.

Trachoma can affect any age group but younger the age at onset of the trachomatous process, the more severe is the disease. In endemic areas, trachoma is most prevalent below the age of 2 years. There is a gradual decline in prevalence after the age of 5 to 6

years. In these areas the active inflammatory stage of trachoma starts during infancy, with gradual conjunctival scarring during school age and adolescence. The most common blinding complication, inverted eyelids, does not appear until the fourth decade of life or later.⁹ Trachoma prevalence is lower in J and K, West Bengal, Maharashtra, Kerala, AP, Orissa, TN and Kerala.

Over the years, blinding trachoma has declined in the country. In 1971 to 74 it was responsible for 5 percent of blindness while in 1986 to 89 the prevalence of blinding trachoma came down to 0.2 percent. Females suffer more from trachoma and also have a higher risk of blinding trachoma.

Environmental risk factors are very important for evolution of trachoma. Trachoma abounds wherever housing conditions are poor, with overcrowding, non-existent domestic sanitation, inadequate water supply and dusty, dirty environment. Flies abound in such circumstances, facilitating infection and reinfection.

Water scarcity has been incriminated as an important determinant. Related to the availability of water is the frequency of face washing; the less the frequency of face washing, the more is the frequency of trachomatous afflictions.

AGE-RELATED MACULAR DEGENERATION (ARMD)

This is the leading cause of blindness in the USA and England. The etiology of this disorder remains unknown. The risk of macular degeneration increases with age, especially after the fifth decade. 2.2 percent of people above 65 years of age go blind every year in USA due to ARMD. 6.4 percent of people aged 65 to 74 years and 19.7 percent of people aged 65 to 74 years and 19.7 percent of those above 75 years have ARMD in USA. In India more than 1 million people have ARMD. The 1986 to 89 ICMR-WHO survey documented that the rate of blindness due to macular and optic nerve diseases is 0.12 percent and 0.08 percent respectively. It is clear that as life expectancy increases, the magnitude of this diseases will increase. There is a 50 percent higher prevalence of ARMD in females in the USA.¹⁰ Persons having hyperopia are more likely to have ARMD, as also cigarette smokers.¹⁰

Onchocerciasis

Endemic onchocerciasis occurs in tropical Africa, Central America and in isolated foci of South America. It is a particularly serious problem in the Savanna belt of West Africa where it has been recognized as a leading public health problem. It is estimated that more than 20 million people are infected and that 500,000 have severely impaired vision.

OCULAR LEPROSY

Great variations in the incidence of ocular complications in leprosy have been reported. It is thought that ocular tissues are ultimately involved in all untreated cases. Conservative estimates suggest that 5.25 percent of leprosy patients may have ocular complications. It is estimated that worldwide, 250,000 leprosy patients are blind.

Measles

Surveys in blind schools in Africa have shown that upon 75 percent of blindness in children is caused by corneal scarring.

Approximately, 50 percent of these children give a history of measles occurring shortly before they became blind. Two out of 5 blind children in Africa may have become blind due to measles.¹¹ Measles infection leads to corneal ulceration and corneal scarring. Blindness results from corneal ulceration which is predisposed by vitamin A deficiency, herpes simplex infection or by use of certain traditional medications. Three doses of 200,000 IU of vitamin A on 1st, 2nd and 7th days should be administered to all cases of measles corneal ulceration. Measles immunization to susceptible children obviously reduces the blindness rate.¹¹

Control Measures for Blindness

The objective of WHO's prevention of blindness team is to assist Member States to effectively prevent blindness and restore sight, when possible. The global target is to ultimately reduce blindness prevalence to less than 0.5 percent in all countries, or less than 1 percent in any country.

Since the estimates of the 90s, the new data based on the world population of 2002 show a reduction in the number of people who are blind or visually impaired, in particular, those who are blind because of infectious causes. But there is an increase in the number of people who are blind or visually impaired due to increasing longevity and the increase of noncommunicable chronic diseases. It will be necessary to adapt the current strategies of prevention and care in order to take into account these demographic and epidemiologic trends.

PRIMARY PREVENTION

Primary prevention can be undertaken at two levels:

Eye Health Promotion

The strategy which can have an everlasting benefit in alleviation of blindness is health promotion. Health promotion strategies protect the individual by preventing

contact with the etiological agent. Eye health education is an extremely important component of this strategy. It aims at:

- Improved personal hygiene, especially face washing, for control of trachoma.
- Improved child nutrition aimed at prevention of vitamin A deficiency
- Augmenting health awareness which will help in early identification and management of cataract and glaucoma cases.

Specific Protection

Specific protection is important in reducing blindness in selected conditions:

- Measles immunization has been documented to reduce measles related blindness.
- Massive dose of vitamin A (2 lakhs IU at 6 monthly intervals) boost the body stores of vitamin A and prevent xerophthalmia.

Improved environmental sanitation and availability of safe water reduce the load of trachoma.

SECONDARY PREVENTION

Early diagnosis and prompt initiation of treatment is the mainstay of any blindness control program. Secondary prevention becomes more important with gradual decline in infective and nutritional factors in etiology of blindness and relative increase in noncommunicable blinding conditions.

A multicentric study on cataract in 1982 to 83 revealed that 7.53 million mature and hypermature cataracts existed in rural area alone and that further 32 million eyes had immature cataract and 18 million incipient cataract. Based on available data, it was estimated that there was a cataract backlog (operable cases) of 22 million in 1990 and that a further 2 million are added to this backlog every year. It is estimated that at the present rate of 1.2 million surgeries per year, the backlog would rise to 30 million by 2000 AD. Early diagnosis and prompt treatment are essential in all these cases. Eye camps, base hospitals and tertiary care centers, all have to play an important role.

A large proportion of glaucoma goes unrecognized in the community. Institution of glaucoma screening in high risk groups would bring these cases to notice and prompt treatment can be instituted.

Early detection and treatment is also important in vitamin A deficiency, leprosy, onchocerciasis, trachoma and diabetes. Mass chemoprophylaxis programs are extremely useful in trachoma (tetracycline) and onchocerciasis (ivermectin).

TERTIARY PREVENTION

Disability limitation and rehabilitation are not as cost effective as strategies aimed at eye health promotion,

specific protection, early diagnosis and treatment. However, physical and vocational rehabilitation are essential for the terminally blind.

National Program for Control of Blindness

National Program for Control of Blindness was launched in the year 1976 as a 100 percent centrally sponsored program. Various activities of the program include establishment of Regional Institute of Ophthalmology, upgradation of Medical colleges and district hospitals and block level Primary Health Centers, development of mobile units, and recruitment of required ophthalmic manpower in eye care units for provision of various ophthalmic services.⁷ The program also extends assistance to voluntary organizations for providing eye care services including cataract operations and eye banking. The goal is to reduce the prevalence of blindness from 1.4 percent to 0.3 percent by 2000 AD.

The infrastructures developed so far (1998) are as follows:

	<i>Infrastructure</i>
• State ophthalmic cell created	21
• Medical colleges upgraded	82
• District hospital upgraded	445
• District mobile units	341
• PHCs augmented	5633
• Eye banks (Government)	166
• District blindness control society	501

Performance of cataract operations has been steadily increasing during last 6 years rising from 16 lakhs in 1992 to 93 to an estimated 40 lakhs cataract operations during 2001 to 2002. Previously most cataract surgery was done by intracapsular cataract extraction but due to better visual restoration with intraocular lens implants (IOL) the National program has been supporting augmenting facilities in the government sector for IOL surgery. Consequently the proportion of IOL implant surgery has increased from 3 percent in 1993 to an estimated 58 percent in 2001 to 2002.

Voluntary organizations are playing an important role in this program. With the success achieved and experience gained through the pilot districts, District Blindness Control Societies (DBCS) have been established throughout the country under the Chairmanship of District Collector/Deputy Commissioner. Training of District Program Managers is being carried out for 2 weeks. The District Blindness Control Society concept aims at decentralization to the district level. The features of the DBCS are as follows:

- Autonomous society to implement blindness control activities
- Representation from government, NGO and private sector

- Decentralized planning, management and monitoring
 - Direct funding from Central Government
 - Empowered to utilize and raise funds
 - Forum for community participation
- Till date, 501 DBCS have been established.

Commodity assistance: Consumable items like sutures and intraocular lenses are procured centrally and distributed to States and DBCS. Equipments, vehicles and other supplies are also procured centrally. Assistance for fixed facilities from central government.

- Construction of dedicated eye ward and eye OT at district and subdistrict level
- Ophthalmic equipment
- Consumable
- Training of eye care team.

Other assistance

- Drugs and consumables for cataract surgery @ Rs 150 per operated case
- Spectacles after surgery @ Rs 75 per case
- Transportation of patients for surgery @ Rs 75 per case
- Sutures and IOLs
- Minor equipment repairs.

The DBCS also provides Grant in Aid to NGO for each operated cataract case at the same norms. If IOL is purchased by the NGO, an additional Rs 200 per case is given to the NGO to meet the cost of the IOL and suture. NGO also gets an additional Rs 50 per case for organizational overheads. Thus NGO is given Rs 400 for non-IOL surgery and Rs 600 for IOL surgery for each case operated (National program for Control of Blindness in India 2001).

Danish International Development Agency (DANIDA):

An agreement was signed between the Government of India and the Government of Denmark to provide support for the development of services under NPCB, during Phase III of Danish Assistance (1998 to 2002) viz. supply of equipments to Mobile Units, PHCs and District Hospitals. It is involved in the following activities:

- Manpower development;
- Establishment of management information systems;
- Supply of equipments and vehicles;
- Preparation of health education material, teaching and information aids; and
- Program support in Karnataka (pilot state project).

World Bank assistance:

A World Bank assisted cataract blindness control project is under implementation since 1994 to 95. The proposed expenditure of the project is Rs. 554 crore during the period of 7 years in the states of Andhra Pradesh, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu and Uttar Pradesh. Major inputs of the project are upgrading the ophthalmic service, expanding the

coverage in rural and tribal areas, establishment and functioning of DBCS, training of ophthalmic manpower, improving the management information system and creating awareness about the programme in the masses.

Under the World Bank Project a sum of Rs. 21 crores was allocated for the year 1994 to 95, Rs. 46.80 crore for the year of 1995 to 96, Rs 42.26 corer for 1996 to 97 and 53 crore for 1997 to 98.

A midterm review of the project was undertaken during 1998 to assess the progress. As a part of midterm review, rapid assessment survey, facility survey and beneficiary assessment survey was undertaken in the seven states covered under World Bank assisted cataract blindness control project. The survey was conducted by independent organization to find out level of prevalence, outcome of surgery, coverage and satisfaction of beneficiaries, their knowledge, attitude and practices for eye care and quality of life after surgery.

Mega eye camps in underserved areas: In the Golden Jubilee year of the India's independence a special program for organizing Mega Eye Camps in underserved areas has been undertaken. The objective of this activity is to enhance coverage of eye care services in general and cataract surgery in particular, to underserved areas of the district. This would include tribal or geographically difficult areas. These camps were organised in two phases. About 3 lakhs additional cataract operations were performed during these two weeks.¹²

SCHOOL SCREENING PROGRAMME

Under the NPCB, all children aged 10 to 14 years will be screened for refractive errors by trained teachers. Children who cannot read the 6/9 line with any eye are then sent to the ophthalmic assistant at the CHC for refraction. Children needing spectacles are then provided free spectacles by opticians who have been contracted by the NPCB. This program is now being implemented all over the country.

Since 2000 to 2001, it has been decided that the NPCB should not be centred around cataract blindness but should undertake a more comprehensive approach to prevention of blindness by targeting other disease responsible for blindness, in addition to cataract.¹³

STOP THE GLOBAL EPIDEMIC OF CHRONIC DISEASE

The WHO Prevention of Blindness (PBL) team works with Member States through WHO regional offices to develop strategies for prevention and control of blindness and visual impairment. Team members, together with our many partners in the field, including NGOs and WHO collaborating centers, work with country-based teams to support the implementation of strategies developed.

In addition, to facilitate ongoing strategic planning, the PBL team coordinates the collection and dissemination at national, regional, and global levels of data that reflect the burden of visual impairment and the implementation of program strategies. The principal area of work of the Prevention of Blindness team (PBL) is elimination of avoidable blindness. Three-quarters of all blindness can be prevented or treated.

VISION 2020: THE RIGHT TO SIGHT: GLOBAL INITIATIVE FOR ELIMINATION OF AVOIDABLE BLINDNESS

After the realization that unless blindness control efforts are intensified, the prevalence of blindness will double by 2020 AD, the WHO along with an International Partnership Committee launched the Vision 2020 Initiative in 1995.

Three essential elements of a global plan were set out as follows.

1. Setting up strategies and targets for disease control
2. Planning human resource needs and development
3. Addressing infrastructure needs and development.

Under the global initiative for the elimination of all avoidable blindness by 2020 AD, all countries are committed to a minimum program. Countries can include other problems than those identified under the minimum program based on their local situation and needs.

The five diseases identified for global elimination include:

1. Cataract blindness
2. Trachoma blindness and transmission
3. Onchocerciasis
4. Avoidable causes of childhood blindness
5. Refractive errors and low vision.

Targets have been set up for each of the component diseases for the next 20 years.¹⁴

Disease Surveillance

Integrated Disease Surveillance Project (IDSP)

Disease surveillance is considered, as the backbone of public health programs in India. Integrated Disease Surveillance Project (IDSP) is a decentralized, State based Surveillance Program in the country launched in November 2004. It is intended to detect early warning signals of impending outbreaks and help initiate an effective response in a timely manner. It is also expected to provide essential data to monitor progress of ongoing disease control program and help allocate health resources more efficiently and optimally. The IDSP proposes a comprehensive strategy for improving disease surveillance and response through an integrated approach. Surveillance activities carried out under various vertical diseases control program, viz, program on malaria, tuberculosis, HIV/AIDS and disease under

RCH program (measles, polio, acute diarrhea) as well as some state specific disease has be integrated under IDSP. This will be effected through data generation using uniform and common reporting formats, collection, compilation and analysis and using common IT network for transmission to state and central levels.

Objectives of IDSP

To establish a decentralized district-based surveillance system for communicable and noncommunicable diseases, to provide data for monitoring progress of ongoing disease control activities and to establish an early warning system for impending outbreaks so that timely and effective public interventions can be instituted and help allocate health resources more efficiently.

Definition of Surveillance

'The ongoing systematic collection, analysis and interpretation of health data essential to planning, implementation and evaluation of public health practice closely integrated with timely dissemination of these data to those who need to know. Surveillance helps to keep a close watch on health events occurring in the community and provides information so that effective action can be taken timely. It provide data (who, where, when do they get the diseases and why?) for planning a disease control program.

Organizational structure: District Surveillance Units at the District level and State Surveillance Unit at the State level implement the Project. A Central Surveillance

Unit has been set up at National Institute of Communicable Diseases New Delhi (**Fig. 21.1**).

Types of Surveillance

Depending on the level of expertise and specificity, disease surveillance in IDSP will be of following three categories:

1. *Syndromic*: Diagnosis made on the basis of symptoms/clinical pattern by paramedical personnel and members of the community based on broad categories of presentation. They will identify Syndrome with fever without any localizing signs/with rash / with cough, AFP, diarrhea, jaundice, unusual events causing death or hospitalization, etc. These syndromes are intended to pick up all priority diseases listed under IDSP.
2. *Presumptive*: Diagnosis made on typical history and clinical examination by Medical Officer.
3. *Confirmed*: Clinical diagnosis by Medical Officer and/or positive laboratory identification.

Diseases Under the Surveillance Project

Considering the disease burden in the community, availability of public health response, special considerations and international commitments following diseases were included for surveillance in the project which is mention in **Table 21.17**.

The disease conditions that are included in the core list and state specific list of the surveillance program will be reviewed periodically and suitably modified.

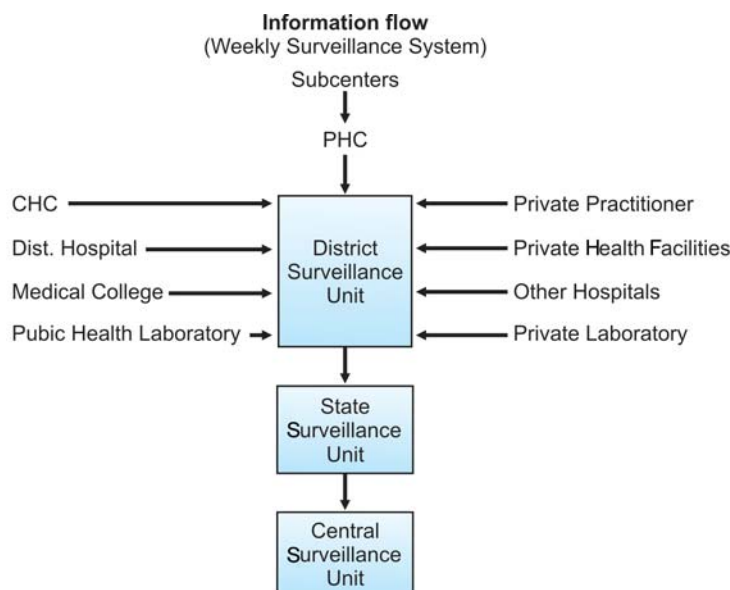


Fig. 21.1: Information flow (Weekly Surveillance System)

TABLE 21.17: List of core diseases

Regular surveillance	Diseases
Vector-borne disease	Malaria
Water-borne disease	Acute diarrheal disease (Cholera) Typhoid Jaundice
Respiratory diseases	Tuberculosis Acute respiratory infection
Vaccine preventable diseases	Measles
Diseases under eradication	Polio
Other conditions	Road traffic accidents
Other International commitments	Plague, Yellow fever
Unusual clinical syndromes (Causing death/hospitalization) distress, hemorrhagic fevers, etc.	Menigoencephalitis/ Respiratory distress, hemorrhagic fevers, etc.
Sentinel Surveillance	
Sexually transmitted diseases/Blood borne	HIV, HBV, HCV
Other Conditions	Water quality Outdoor air quality (Large urban centers)
Regular periodic surveys	
Noncommunicable disease risk factors	Anthropometry, Physical activity, Blood pressure, Tobacco, Nutrition
State specific diseases	Dengue, Japanese Encephalitis, Leptospirosis, Arsenicosis

TABLE 21.18: Clinical syndromes and diseases under each syndrome

Syndromes	Diseases
Fever with and without localizing signs	Malaria, Typhoid, JE, Dengue, Measles
Cough more than 3 weeks duration	Tuberculosis
Acute Flaccid Paralysis	Polio
Watery Diarrhea	Cholera
Jaundice	Hepatitis, Leptospirosis, Dengue, Malaria,
Unusual Events causing death or hospitalization	Anthrax, Plague, Emerging epidemics

Syndrome is group of symptoms and/or signs attributable to particular disease condition (e.g. fever with skin rash indicative of measles).

Syndromes Under Surveillance

The paramedical health staff will undertake disease surveillance based on broad categories of presentation. The following are the clinical syndromes and diseases under each syndrome (**Table 21.18**).

Surveillance of fever: Fever is the most common presenting symptom among patients at the periphery. Fever may be accompanied by other symptoms, e.g. fever with cough/ muscle pain, a patient is considered to be suffering from fever, if his/her main symptom is that of fever.

Fever less than seven days with:

- Rash and running nose or conjunctivitis (suspected Measles)
- Altered sensorium (suspected JE)
- Convulsions (suspected JE)
- Bleeding from skin, mucus membrane, vomiting blood or passing fresh blood through nose or ear or black motion (suspected dengue)
- With none of the above (suspected malaria)

Fever more than seven days (suspected typhoid)

While entering the diagnosis for fever, care must be taken to record it as one of the following categories:

- Only fever/Fever with rash/Fever with altered consciousness or convulsions/Fever with bleeding/ Fever more than 7 days.

Methods of Surveillance

The following are the main sources of data under IDSP:

- **Routine reporting (passive surveillance):** It is most major form of data collection and universalized, while other methods are need and area specific. Health Worker/ANM reports all patients fulfilling the clinical syndrome from area covered by the sub-centre. Medical Officers at Primary Health Centre (PHC) or Community Health Centre (CHC) level will report as probable cases or confirmed cases as applicable. It is suggested that each of the units report at weekly intervals.

- *Sentinel surveillance*: a hospital, health center, laboratory or a rehabilitation center that caters to a relatively large number of cases of the disease can be considered as a sentinel center. Data from sentinel centers of public health care system as well as that from private sector are useful to determine trends in the incidence of the disease and can trigger action for outbreak investigation. This form of surveillance will be used for HIV, HBV, HCV, Water Quality, Air Quality etc.
- *Active surveillance (active search for cases)*: Active search is resource intensive; it may be carried out under some specific circumstances such as during outbreaks, Acute Flaccid Paralysis (AFP) case search, to know the magnitude of a problem, etc.
- *Laboratory surveillance*: The laboratory network under IDSP will report independently all confirmed cases which allow understanding and validating the changes in pattern of syndromes and probable cases seen at the reporting centers. It also helps in diagnosis of cases for case management and feed back of laboratory reports on a case to the reporting units. This facilitates identification of new agents and changes in the behavior of microorganisms especially in relation to susceptibility to anti-microbials.
- *Sample surveys*: Surveys may be conducted to collect baseline data prior to the launch of a large control program, especially if such data are lacking through other sources. In IDSP Non communicable diseases (NCD) risk factors will be collected through regular surveys (3 to 5 yearly). Surveys give reliable epidemiological information, however it is difficult to conduct and are relatively expensive.
- *Vector surveillance*
- *Outbreak investigations*: Outbreak investigation is the primary method of confirming emerging infections. This provides information on magnitude, distribution and possible cause of outbreak.
- *Special studies*: Special studies are sometimes required to study a specific problem (e.g. increased prevalence of cases due to environmental pollution, multi-drug resistant microorganisms), which is not available by other means.

Collection and Transmission of Data

The health workers or village level volunteers collect data by Syndromic surveillance and record the number of these syndromes in a register locally and report it to the next level on a weekly basis since most diseases with epidemic potential has a short incubation period. Each sentinel site will record selected disease conditions by prior agreement but will send regular weekly report including zero reporting. If there are more than expected number of cases of particular syndrome, the Medical Officer inform DSU and initiate epidemic investigation.

Feedback and Sharing Information

Sharing of information with all stakeholders for effective public health action is the primary purpose of the IDSP. Regular reports generated at different level would be shared with all the stakeholders as relevant. Feedback report should also be provided on the quality of data submitted. Feedback is essential to maintain and support the peripheral staff.

Analysis

Analysis is necessary at all levels for the optimum utilization of information. Most of the primary analysis would be automatic background activity of the computer program at the district and state levels. The analysis would reveal trends of disease, of time and space, and produce reports regularly, and on detecting deviations from the normal. The district and state surveillance officer will perform specific additional analysis required for each disease. However, at the periphery only frequency tables are necessary and this will be automated by the use of computers. The analyzed reports need to be sent to the stakeholders at different level and will guide the surveillance actions. After preliminary analysis if it found to cross the threshold, the HW should take immediate action.

- Initiate response at appropriate level
- Monitor disease control programs
- Identify emerging epidemics
- Assist in allocation of resources
- Mobilization of public support for health programs

RESPONSE TO THE SURVEILLANCE INFORMATION

Every disease needs a basic number of cases in order to sustain the transmission to other vulnerable in the population called threshold level; if the a disease reaches this threshold level, there is a risk of an outbreak of that disease. The IDSP manuals set out case definitions and trigger levels (e.g. number of suspected cases in a specified time and location) for each of the diseases/health conditions under surveillance. When the trigger levels are crossed for communicable diseases appropriate responses has to be made. Details are given in the District Operations Manuals for the project.

Integrated Management of Childhood Illness (IMCI)

Though global childhood mortality rates continued falling but its progress has been extremely uneven; in some countries the rates are on the increase and in many, especially in sub-Saharan Africa, they remain shockingly high.¹⁵ The evidence showed that a large

proportion of childhood morbidity and mortality in the developing world is caused by just few conditions only: acute respiratory infections (mostly pneumonia), diarrhea, measles, malaria, and malnutrition. Often the sick children present with combination of signs and symptoms related to one or more of these conditions. This overlap means that a single diagnosis may be neither possible nor appropriate and may need an integrated approach in management of these cases. WHO in collaboration with UNICEF, has responded to this challenge by developing a strategy for *Integrated Management of Childhood Illness (IMCI)*. IMCI is an effective, low-cost strategy for improving child health through prompt recognition of all coexisting conditions, rapid and effective treatment based on standard case management and prevention of illness by improving nutrition including breastfeeding, and vaccination in 1 week to 5 years age group children. The three components of IMCI for implementation in a country include: *improving health workers' skills, improving health systems to support IMCI, and improving family and community practices*. In health facilities, the IMCI strategy promotes the accurate identification of childhood illnesses in outpatient settings, ensures appropriate combined treatment of all major illnesses, strengthens the counseling of caretakers and the provision of preventive services, and speeds up the referral of severely ill children. It also aims at improving the quality of care at the referral level also. At home level it promotes appropriate care-seeking behaviors, improved nutrition and preventive care, and the correct implementation of prescribed care.¹ The clinical guidelines in IMCI strategy are evidence based assessment and management of illness using a syndromic approach that support rational, effective and affordable use of drugs.

Adaptation of IMCI to IMNCI in India

Considering the fact that majority of the infant deaths occur in the first week of birth, India adopted IMCI strategy with additional component of newborn care for 0 to 7 days age and renamed as Integrated Management of Neonatal and Childhood Illness (IMNCI).¹⁶ In India, IMNCI is a component of Reproductive and Child Health (RCH) II program.

Integrated Management of Neonatal and Childhood Illness (IMNCI)

Integrated Management of Neonatal and Childhood Illness (IMNCI) is an integrated approach that includes

the assessment, classification and management of the major health problems a sick infant or an under five child may suffer. It also includes assessment of nutritional and immunization status of all sick infants and children. Indian version of IMNCI also includes home visits for all newborns to teach the mother ways to prevent illnesses through exclusive breastfeeding and essential newborn care. The case management process under IMNCI strategy involves the following elements:

- **Assessment:** All sick young infants up to 2 months of age must be assessed for “*possible bacterial infection/jaundice*” by asking certain specified question and examining the child. They are also assessed for the major symptom of “*diarrhea*” and *breastfeeding*. All sick children age 2 months up to 5 years must be examined for “*general danger signs*” which indicate the need for immediate referral or admission to a hospital. They must then be *routinely assessed for major symptoms:* cough or difficult breathing, diarrhea, fever and ear problems. All sick young infants and children 2 months up to 5 years must also be routinely assessed for *nutritional and immunization status, feeding problems, and other potential problems*. Only a *limited number of carefully selected clinical signs* are used, based on evidence of their sensitivity and specificity to detect disease. These signs were selected considering the conditions and realities of first-level health facilities.
- **Classification of illness:** A combination of individual signs and symptoms leads to an infant’s or a child’s *classification(s) rather than a diagnosis*. Classification(s) indicate the severity of condition(s). They call for specific actions based on whether the infant or child (a) should be urgently referred to a higher level of care, (b) requires specific treatments (such as antibiotics or antimalarial treatment), or (c) may be safely managed at home. The illnesses are classified using a color coded management chart. This chart is organized in three different colors viz. red, yellow and green for easy identification and management. Following are significance of the color code of illness:
 - Conditions under red color (or pink) indicate severe illness. Children with a severe illness must be referred to a hospital or sent to the doctor.
 - Conditions under yellow color should be treated with medicine at home and home care advice to the mother.
 - Conditions under green color are to be treated with home care without the use of medicines.
- **Identify:** Relevant treatment and action based on assessment and classification.

- *Management:* IMNCI management procedures use a *limited number of essential drugs* and *encourage active participation of caretakers in the treatment* of infants and children. Treatment instructions are given and referred when required, including information on follow up visit. It also teaches how to recognize danger sign and should return immediately.
- *Counseling of caretakers:* This includes assessment of feeding and breastfeeding and counsel to solve any problem and encourage correct practices.

Management of sick child discussed in two parts

1. Management of young infants age up to 2 months (0 to 59 days old)
2. Management of sick children 2 months up to 5 years (2 to 59 months).

Health workers or paramedical worker are supposed to use a learner's module and a color-coded management chart to provide care to the sick children in community and at routine home visits for new borns. Sick young infants are somewhat different from older children. Sick young infants (0 to 23 months) frequently have only general signs like lethargy, low body temperature or fever. They can become sick very quickly and may die within a few hours or days. These are some of the reasons why young infants have to be managed differently. Refer the management chart for details.

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We have discussed the environment, host and agent factors affecting health in section 2, 3 and 4 respectively. However, the topic of food and nutrition must be discussed separately because it represents an interesting interplay of all the three factors and cannot belong exclusively to any one of the above three sections. The present chapter is organized into the following eight parts:

1. Epidemiological aspects
2. Nutrients and proximate principles of food
3. Foods and food groups
4. Preservation of foods and conservation of nutrients
5. Diet standards and diet planning
6. Malnutrition including National Nutrition Programs and Obesity
7. Food hygiene
8. National nutrition policy.

Before further discussion, it is appropriate here to define nutrition and to look into its various divisions.

Nutrition is a science that deals with all aspects of interaction between a living organism and the substances which help the organism to grow and sustain itself. There being three types of living organisms (plants, animals and men), nutrition may be said to have different specialities, viz., plant nutrition, animal nutrition and human nutrition.

Human nutrition deals with food and nutritional requirements of human beings at different age, sex and physiological status, nutritional imbalances in human beings and various measures for overcoming such deficiencies and imbalances.

Clinical nutrition is that branch of human nutrition dealing with the physiological, pathological and therapeutic aspects of nutrition.

Public health nutrition is the branch of human nutrition dealing with human health and the services necessary to maintain human health. It deals with whatever can be done through national health services and other health related agencies and institutions to promote human nutrition. Community nutrition to promote human nutrition. Community nutrition is same as public health nutrition.¹

Epidemiological Aspects

There is an inseparable association between nutrition and health. In different situations, nutrition may act as an environmental, host or agent factor influencing health.

Food and Nutrition as Environment

Like air and water, food is an essential part of man's everyday environment and harbours various agents of disease, chemical as well as biological, described later. Examples of chemical disease agents transmitted through food as a vehicle are heavy metals like lead, copper and mercury,² food toxins like BOAA (from *Lathyrus sativus*), sanguinarine (from *Argemone mexicana*), alkaloids causing VOD or venoocclusive disease³ (from *Crotalaria* and *Heliotropium*) carcinogens like aflatoxins, food adulterants like orthophel phosphate (added to rapeseed oil to make it look like mustard oil) and several harmful dyes for imparting color to foods (e.g. polished blue VR dye to make peas look fresh), brominated vegetable oil (BVO, added to bottled cold drinks to impart them a stable cloudiness), etc. and food contaminants like DDT and other pesticides. Examples of biological disease agents in foods are the various bacterial, protozoal and helminthic infections transmitted through foods, already described in previous chapters. Food also forms an important component of social environment. From times immemorial, food has formed an essential part of religious and social practices. Such practices may be in the form of offering rice, ghee, sweets, etc. to Gods and Goddesses by Hindus; sacrificing animals by the tribals and passing around of bread and wine by the Christians. Social intercourse, conflicts and revolutions have often central around food. Salt, tea and spices have been important items of trade among different countries. The historical Dandi March undertaken by Mahatma Gandhi during India's struggle for independence was centered around salt. Even in modern times, food and alcohol are an intergral part of our social environment. On the one hand food prices exert enormous influence on the social front, causing large scale public demonstrations and strikes and influencing wide ranging political

decisions. On the other, major political, commercial and industrial decisions are often taken at meetings held in the background of lavish dinners and executive lunches.

Food and Nutrition as Host Factors

Needless to say, nutritional status is a very important determinant of health. Deficiencies of energy, vitamin A, iodine, iron and riboflavin are widely prevalent in India.⁴ These deficiencies, in turn, lead to protein-energy malnutrition, xerophthalmia, iodine deficiency disorders, nutritional anemia, etc. which account for a heavy toll of morbidity and mortality. For example, almost one-third children born in India are malnourished at birth, i.e. they have low birth weight (LBW). The mortality among these children is 3 to 4 times of that found in the normal weight babies. Low birth weight, in turn, is determined by maternal malnutrition. Another example of nutritional status as a host factor influencing health and outcome of disease is the well-known relation between nutrition and infection. It is well-documented that while measles may be a minor passing illness in well-nourished children, it may be fatal in children with malnutrition.

Food and Nutrition as Agent Factors

Several nutrients are important disease agents. In this context, it should be remembered that an agent is defined as a living or nonliving substance or a tangible or intangible force, the excessive presence or *relative lack* of which may initiate or perpetuate a disease process. Accordingly, vitamin A is an agent of xerophthalmia and hypervitaminosis A, vitamin D of rickets and hypervitaminosis D, thiamine of beriberi, energy of marasmus and obesity, saturated fats of hypercholesterolemia, fiber of constipation and diverticulosis, iron of anemia and siderosis, fluorine of caries and fluorosis and iodine of endemic goiter.

Nutrients and Proximate Principles of Food

Food consists of seven main components—carbohydrates, fats, proteins, vitamins, minerals, water and fiber. These components provide the six types of nutrients essential for human body, viz. energy, protein, vitamins, essential fatty acids, minerals and water. Fiber, though not usually labeled as a nutrient, is an important component of food and its deficiency gives rise to various disease syndromes. The basic role of fats and carbohydrates in nutrition is similar, i.e. to act as source of energy. It is true that fats also supply the essential fatty acids, but the deficiency of the latter is rare. Proteins, fats and carbohydrates are sometimes referred to as proximate principles of foods.

Proteins

Dietary proteins provide amino acids for the synthesis of body proteins, both structural proteins and biologically active enzymes and other biologically important nitrogenous compounds in the body. Proteins are primary structural and functional components of every living cell. Proteins perform a wide range of functions and also provide energy (4 kcal/g).

Body proteins are made up of twenty amino acids, eight of which are essential, i.e. these cannot be made in the human body and must be present as such in food in adequate amounts. These are isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. In addition, histidine is an essential amino acid for infants. Animal proteins, in contrast to plant protein, have an amino acid pattern that resembles the human tissue proteins more closely. Therefore animal proteins have a better quality than plant proteins. But plant proteins may be combined judiciously to derive a good quality protein mixture. A classical example is a cereal pulse combination in which the lysine deficiency of cereals is made up by pulses and the methionine deficiency of pulses is made up by cereals. Quantitatively the quality of a protein can be worked out in terms of biological value, digestibility co-efficient, net protein utilization, protein efficiency ratio and amino acid score. The quality of protein is expressed in terms of its *biological value*, which is defined as:

$$BV = \frac{\text{Nitrogen retained in the body}}{\text{Nitrogen absorbed}} \times 100$$

$$\text{Digestibility co-efficient} = \frac{\text{Nitrogen absorbed} \times 100}{\text{Nitrogen intake}}$$

$$\text{Net Protein Utilization (NPU)} = \frac{\text{Retained Nitrogen} \times 100}{\text{Intake of Nitrogen}}$$

$$\text{Protein Efficiency Ratio (PER)} = \frac{\text{Weight gain in g}}{\text{Protein intake in g}}$$

It is usual to express protein in terms of its nitrogen content, which is about 16%. The biological value of milk protein (casein) or egg albumin, which are termed as standard or reference proteins, is 100%. Another common method of expressing protein quality is the *amino acid score*.

$$\text{Amino acid score} = \frac{\text{mg/g of limiting amino acid in the test protein}}{\text{mg/g of the particular amino acid in reference protein}} \times 100$$

The *limiting amino acid* is that amino acid in a protein which is relatively most deficient compared to reference protein. In practice, the limiting amino acids in foods are only four: lysine, methionine, cysteine and tryptophan. Wheat is deficient in lysine and pulses in methionine, the relative lack of a particular amino acid can be compensated by simultaneous consumption of another protein, which contains that limiting amino

TABLE 22.1: Biological value of protein of common foods

Food	Biological value
Egg	96
Milk	90
Meat	74
Wheat	66
Maize	50
Rice	80
Bengal gram	74
Red gram	72
Groundnut	55
Gingili	62

acid. This is known as *supplementary action*. The protein value of some common foods is given in **Table 22.1**.

Recommended Protein Intakes for Indians

Daily protein requirement of different age groups should be expressed as gram per kilogram of body weight (**g/kg/d**). The safe level of requirement should be expressed as Mean +1.96 SD while Mean -1.96 SD should indicate the minimal requirement. The safe protein intake at different ages is given per kg body weight as well as total requirement for a normal individual are given in **Table 22.2A** for adults and in **Table 22.2B** for infants and children. Total daily requirement of normal population

TABLE 22.2A: Protein requirement for normal Indian adults and allowances for pregnant and lactating women^a

Group	Body weight kg	Protein* g/kg/d	Daily additional requirement* (g)	Total daily requirement* (g)
Adult				
Male	60	1.0		60
Female	55	1.0		55
Pregnant women (3rd trimester, 10 kg GWG)			23 ^b	78
Lactating women				
0-6 months			19 ^b	74
6-12 months			13 ^b	68

^a Terms of mixed Indian diet protein; ^b High quality protein, GWG: Gestational weight gain

* Sources: ICMR 2010

The daily requirement for Indian children, computed for their growth, is given in **Table 22.2B**.

TABLE 22.2B: Protein requirement and dietary allowances for infants, Boys and Girls

Age Group	Requirement ^{a,b} g protein kg/d	Body weight (kg)	Total daily requirement (g protein/d)	Requirement ^{a,b} g protein/kg/d	Body weight (kg)	Total daily requirement (g protein/d)
Infants ^c (Months)						
6-9	1.69	7.9	13.4			
9-12	1.69	8.8	14.9			
Pre-school Children(y)		Boys			Girls	
1-2	1.47	10.3	15.1	1.47	9.6	14.1
2-3	1.25	12.8	16.0	1.25	12.1	15.1
3-4	1.16	14.8	17.2	1.16	14.5	16.8
4-5	1.11	16.5	18.3	1.11	16.0	17.8
School Children (y)		Boys			Girls	
5-6	1.09	18.2	19.8	1.09	17.7	19.3
6-7	1.15	20.4	23.5	1.15	20.0	23.0

is computed by multiplying the per kg value at different age with the corresponding normal standard body weights.⁵

Sources of Protein in Diet

ANIMAL FOODS

Milk, egg, meat and fish are good sources of high quality protein, but are often available only to the rich.

VEGETABLE FOODS

Pulses contain 20 to 25% protein and are called poor man's meat. A still more important source is cereals with a protein content of 8 to 13%. Since they are taken in bulk, cereals form the main source of protein in diet. They account for 50% of the world intake of proteins.

Protein content in 100 gm of some food is as follows **Table 22.3**.

Fats

Fats are chemically triglycerides, i.e. esters of glycerol and lower saturated and unsaturated fatty acids and are classified as animal fats and vegetable fats. However, the term fat is often loosely used as a synonym for lipids which include triglycerides, phospholipids and sterols.

Contd...

Age Group	Requirement ^{a,b} g protein/kg/d	Body weight (kg)	Total daily requirement (g protein/d)	Requirement ^{a,b} g protein/kg/d	Body weight (kg)	Total daily requirement (g protein/d)
7-8	1.17	22.7	26.6	1.17	22.3	26.1
8-9	1.18	25.2	29.7	1.18	25.0	29.5
9-10	1.18	28.0	33.0	1.18	27.6	32.6
Adolescents (y)		Boys			Girls	
10-11	1.18	30.8	36.3	1.18	31.2	36.8
11-12	1.16	34.1	39.6	1.15	34.8	40.0
12-13	1.15	38.0	43.7	1.14	39.0	44.5
13-14	1.15	43.3	49.8	1.13	43.4	49.0
14-15	1.14	48.0	54.7	1.12	47.1	52.8
15-16	1.13	51.5	58.2	1.09	49.4	53.8
16-17	1.12	54.3	60.8	1.07	51.3	54.9
17-18	1.10	56.5	62.2	1.06	52.8	56.0

^a In terms of mixed Indian vegetarian diet protein.

^b Requirements for each age band taken as the protein requirement for the lower age limit at that age band.

Source: ICMR 2010

Table 22.3: Protein content in 100 gm of some foods

Cow's milk	3.2%
Human milk	1.1%
Buffalo milk	4.3%
Meat	22.5%
Egg	13.3%
Fish	22.0%
Groundnuts	25.3%
Atta raw, handpounded	12.1%
Rice	7.5%
Pulses	20.25%
Soybean	43%

Fats are distinguished from oils by their different melting points; fats are solid and oils liquid at room temperature. Fat is one of the major sources of calorie to the body, which provides 9 calories of energy per gram. It helps in digested, absorbed, and transportation of fat soluble vitamins A, D, E, and K.

The dietary fatty acids have been subdivided into three broad classes according to the degree of unsaturation; saturated fatty acids (SFA) have no double bonds, monounsaturated fatty acids (MUFA) have one double bond and polyunsaturated fatty acids (PUFA) have two or more double bonds.

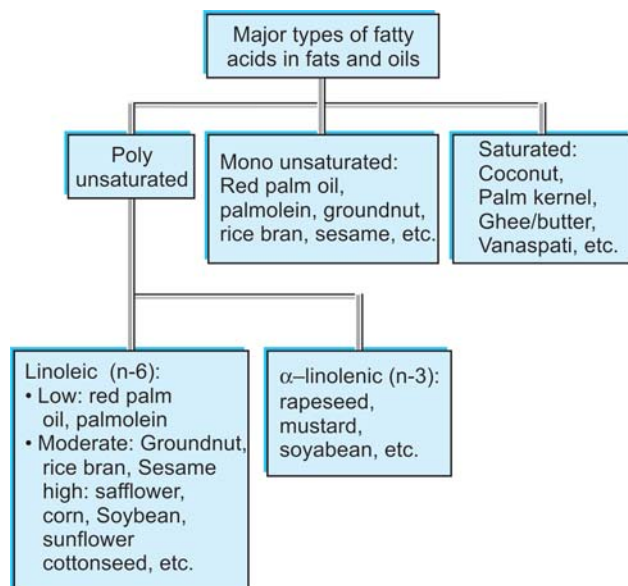
A *cis* configuration means that the hydrogen atoms attached to the double bonds are on the same side. If the hydrogen atoms are on opposite sides, the configuration is termed *trans*. Each broad classification of fatty acids may have unique biological properties and health effects.⁸ Trans fatty acids are produced during the partial hydrogenation of PUFA. Trans fatty acids have been associated with adverse effects on lipoprotein status by elevating LDL and depressing HDL. Trans fatty acid formation occur when oil is heated over and over

again during frying with oil especially when same oil used repeatedly.

Poly unsaturated fatty acids (PUFA) are essential components of cell membranes. The n-6 PUFAs are predominant in all cells, while the nerve tissue has high levels of long chain n-3 PUFA. The two most important polyunsaturated essential fatty acids namely, linoleic (n-6) and linolenic acid (n-3) are metabolized at various sites in the body to generate a group of biologically-active compounds, which perform several important physiological functions. Further, PUFAs reduce total cholesterol; influence peripheral glucose utilization, insulin action and decrease adiposity and hence are anti atherogenic. On the other hand **saturated fatty acids** are known to increase serum total, LDL cholesterol levels, reduce insulin sensitivity and increase CVD risk. Excessive fat in the diet increases the risk of obesity, heart disease, stroke and cancer.⁸ Replacing SFA with MUFA reduces LDL cholesterol concentration and total/HDL cholesterol ratio.

SOURCE OF FAT

Dietary fats can be derived from plant and animal sources. Fats that are used as such at the table or during cooking are termed as “visible” fats; and that present as an integral components of various foods are referred to as “invisible” fat. Fats, in processed and ready to eat foods are known as hidden fats. Cereals contain only 2 to 3% of invisible fat. A typical Indian diet contain significant amount of invisible fat. Major sources of dietary SFA are from animal fat and especially from ruminant dairy fats. Appreciable levels of SFA are also present in some tropical oils, such as palm oil, coconut oil, etc.



Oleic acid (OA) is the most common MUFA and it is present in considerable quantities in both animal and plant sources commonly in marine oils and vegetable oils. Nutritionally important n-6 PUFA includes linoleic acid, α -linolenic acid, arachidonic acid, docosatetraenoic acid, etc. Nutritionally important n-3 PUFA, α -linolenic, stearidonic acid, eicosapentaenoic acid which is found in flaxseed oil, perilla oil, canola oil, soybean oil, etc.

RECOMMENDED INTAKE⁵

The total fat (visible + invisible) in the diet should provide between 15 and 30% of total calories. Excess intake of saturated are associated increase CVD risk, therefore, SFA intake should not exceed 8 to 10% of total energy. One should reduce both saturated fat and cholesterol intake by limiting the consumption of fat animal foods like butter, ghee, meat, egg and organ meats and consuming low fat (skimmed) milk instead of whole milk. However, consumption of eggs (3 eggs/week) is recommended in view of several nutritional advantages.

The intake of PUFA should be 8 to 10% of energy intake. The remaining 8 to 10% of fat calories can be derived from mono-unsaturated fatty acids, which also help in maintaining plasma cholesterol. Further, to get a good proportion of all the classes of fatty acids, it is advisable to consume more than one type of vegetable oils.

An appropriate balance of these two classes of PUFA (e.g. n-6 linoleic and n-3 linolenic acids) in the diets is essential for the functioning of vascular, immune, nervous and renal systems and for early human development. Linoleic acid (LA) and alpha-linolenic acid (ALA) are indispensable since they cannot be

synthesized by humans. The minimum intake levels for essential fatty acids to prevent deficiency symptoms are estimated to be 2.5% of total energy from LA plus 0.5% of energy from ALA.

Higher dietary cholesterol increases blood cholesterol. Therefore, cholesterol intake should be maintained below 200 mg/day.

CHOICE OF COOKING OILS⁵

The recommended ratio of polyunsaturated/ saturated (PUFA/SFA) fat is 0.8 to 1.0, and that of linoleic/ -linolenic (n-6/n-3) is 5 to 10 in the total diet. An appropriate balance of fatty acids may be obtained by to increasing the α -linolenic acid (n-3) intake and reducing the quantity of linoleic acid obtained from the cooking oil. Hence, the choice of cooking oil should be any one of the following combinations.

- Groundnut/Seasame/Rice bran + Mustard
- Groundnut/Seasame/Rice bran + Canola
- Groundnut/Seasame/Rice bran + Soybean
- Palmolein + Soybean
- Safflower/Sunflower + Palmolein + Mustard
- Safflower/Sunflower + Groundnut/Seasame/Rice bran.

ESSENTIAL FATTY ACIDS

Three unsaturated fatty acids, namely linoleic, linolenic and arachidonic acids, must be supplied in diet since the body cannot manufacture them *de novo*. Hence these are known as essential fatty acids (EFA). Of these, linolenic and arachidonic acids can be derived from linoleic acid in the body. Hence, truly speaking, linoleic acid is the only essential fatty acid. EFAs are components of our cytoarchitecture and are also the precursors of prostaglandins. EFA deficiency is virtually unknown except in experimental situations and in patients on total parenteral nutrition. When it does occur, however, EFA deficiency manifests through stunted growth and dry, scaly skin lesions.

Vanaspati

It is a popular cooking medium prepared by hydrogenation of groundnut, sesame, rapeseed, cottonseed and other vegetable oils. On hydrogenation, the color and odor are removed and melting point is raised. In the process, however, the unsaturated fatty acids become saturated and converted into trans fatty acids which may increase the risk of heart disease. Therefore, it is essential to limit the intake of trans fatty acids within 2% of total energy intake. Under government regulations, 2500 IU of vitamin A are added per 100 gm of vanaspati. Most manufactures also add about 200 IU of vitamin D.

Carbohydrates

Carbohydrates form the main bulk of diet. The major carbohydrates in diet are starch, sucrose (cane sugar) and lactose (milk sugar). Chemically, plant fiber, though indigestible by man, is also carbohydrate. The main role of carbohydrates in nutrition is to serve as a source of energy. The carbohydrate content of flesh foods is negligible.

STARCH VS SUCROSE

Although generalizations are misleading, it might be said that in Indian diets, carbohydrate calories come mostly from starch, whereas in Western diets, about 40% of carbohydrate calories come from sucrose. From a physiological point of view, it is better to take more of starch and to minimize sucrose intake. This is so because sucrose is quickly split into hexoses, which are rapidly absorbed, giving rise to sudden marked elevation of blood glucose levels. Some *pathophysiological implications of high sucrose intake* are discussed below.

Obesity

Sweets do not need much chewing and are palatable. As a result, it is all too easy to consume a large number of calories in the form of sucrose-rich foods such as candy, cake and icecream. High caloric intake creates a strong predisposition to obesity.

Nutrient Depletion

Starch in natural foods is associated with protein, vitamins, minerals and fiber. Sucrose, on the other hand, is pure carbohydrate. Thus replacing starch by sucrose tends to deplete the diet of many essential nutrients.

Diabetes

The glycemic and insulin response to sucrose differs from that to starch in view of the sudden, sharp rise in blood glucose following sucrose intake. The hyperglycemic stress is less in case of starch, particularly if it is associated with protein, fat and fiber. High intake of sucrose over the years means a lot more work for the beta cells of pancreatic islets of Langerhans. This might eventually lead to exhaustion of the beta cells and consequent diabetes. The difference in glycemic response to sucrose and starch also means that a person with mild diabetes may manifest diabetes on a high sucrose diet but not on a high starch diet.

Dental Caries

Sucrose is a highly suitable substrate for the growth of several bacteria in the oral cavity. These bacteria

produce acids in the course of their metabolic reactions. Acid has a slow but definite corrosive effect on dental enamel, with the result that high availability of sucrose in the mouth over a period of time may eventually lead to cavities in the teeth. The most *harmful effects of sucrose are seen if:*

- Sucrose does not have much company. For instance, candy is more harmful than chocolate. Similarly, 'lemon drops' would be more harmful than 'burfi'.
- The preparation sticks to the teeth.
- The mouth is not cleaned immediately after consuming the sweet. Even five minutes are adequate for bacteria to produce potentially dangerous amounts of acid.

DIETARY FIBER

These are carbohydrates in plant foods resistant to the endogenous digestive enzymes of the human gastrointestinal tract. Traditionally, fiber was considered to be an inert part of food, not digested by the body but increase the bulk of the food. This view has been changed and the term fiber now includes complex carbohydrates and natural polymers such as cellulose and woody plant lignin, as well as pectin and various gums like arabic, agar and psyllium. Fiber is broadly classified into two groups – insoluble and soluble forms.

Wheat bran, an insoluble form is a good stool softener but a poor absorber of cholesterol unlike soluble form. Insoluble form increases the bulk of stool and speeds their passage through the gut. Whole grains such as oats and wheat bran, and skin of many fruits, vegetables are good sources of insoluble fiber.

Soluble form is a good absorber of cholesterol, as it forms a gel while passing through digestive tract. Some hemicellulose, betaglacans and other compounds found in oats, legumes (lentil, peas), some vegetables (broccoli) and fruits are good source of soluble fiber.

The pathophysiological implications of fiber are described below:

Constipation and Related Disorders

The stimulus for the defecation reflex is rectal distention. The frequency and ease of defecation depends upon the volume and consistency of distal colonic contents. Dietary fiber increases the volume of stools as well as softens the consistency. Conversely, deficiency of fiber leads to constipation. The worst aspect of constipation is not the decreased frequency of defecation but, rather, the hardness of the stool. Hard stool needs straining and straining means increased intra-abdominal as well as intracolonic pressures. The sequelae of these raised pressures are hemorrhoids, hernia, diverticulosis and varicose veins.

Diabetes

Fiber attenuates the glycemic response to an oral carbohydrate load. Hence fiber also possibly plays a role in prevention of diabetes as in case of starch discussed earlier.

Atherosclerosis

There is limited evidence that some components of dietary fiber may lower total serum cholesterol and low density lipoprotein (LDL) cholesterol level, and raise high density lipoprotein (HDL) cholesterol level. These changes are associated with reduced risk of atherosclerosis.

Cancer

There is a direct relation between low fiber diet and cancer, especially cancer of colon. Low fiber diet is associated with less fecal volume, resulting in higher concentration of carcinogens ingested along with food. Bowel mucosa is, in fact, exposed to this higher carcinogen concentration for an unduly long period, since low dietary fiber intake is associated with increased stool transit time.

It would appear from the above that fiber is an essential nutrient in its own way. The most practical way of including sufficient fiber in the diet are:

- Whole cereals should be preferred to refined cereals. Wheat flour should not be passed through a sieve prior to making the dough.
- Whole pulses should be preferred to those from which the husk has been removed.
- Fruits and vegetables that can be eaten with the skin intact should be eaten as such. However, fruits and vegetables are poorer sources of fiber than cereals and pulses.

Minerals

Minerals, like vitamins, are micronutrients. The minerals which are most commonly deficient are iron and iodine. Calcium deficiency may also occur sometimes. Deficiency of other minerals is either rare or not well documented.

Iron

It is the essential constituent of hemoglobin in the red blood cells. Out of the total estimated 3 to 4 gm in the body, 75% is present in blood.

SOURCE

Main dietary sources of iron are cereals, pulses, meat, eggs and green leafy vegetables. Gur (jaggery) also has significant amounts of iron. Milk is a poor source. Vitamin C helps in iron absorption.

The recommended daily intake of iron⁶ is 28 mg for men, 30 mg for nonpregnant women and 38 mg for pregnant women. Iron deficiency leads to microcytic-hypochromic anemia.

Iodine

It is an essential part of thyroxine hormone which helps in the oxidation process of the body and regulates metabolism. All biological actions of iodide are attributed to the thyroid hormones. Thyroid hormones in turn play a major role in the growth and development of the brain and central nervous system in humans from the 15th week of gestation to 3 years of age. The iodine content of food depends on the iodine content of the soil in which it is grown.⁹

RECOMMENDED INTAKES FOR IODINE⁹

The World Health Organization together with UNICEF in 2001 made following recommendations for dietary intake of iodine:

- *Infants*: An iodine intake of 90 $\mu\text{g/day}$ from birth onwards.
- For 1 to 10-year-old child would be 90 to 120 $\mu\text{g/day}$.
- Adolescents and adults requirement for iodine is 150 $\mu\text{g/day}$.

Table 22.4 shows the iodine content of foods.¹¹ Sea salt is a poor source of Iodine.

TABLE 22.4: Iodine content of foods

Food groups	Mean iodine contents (microg/kg weight)
Sea fish	832
Fresh water fish	30
Vegetables	29
Meat	50
Eggs	93
Legumes	29
Cerebral grains	47
Fruits	18

Calcium

It forms 1.2 to 2% of body weight, 99% being present in bones and teeth. Its serum level is about 10 mg per 100 ml. The proportion in blood and bone is maintained by the interaction of vitamin D, calcitonin and parathyroid hormone. Calcium controls neuromuscular action, including cardiac muscle contraction. It is essential for coagulation of blood.

SOURCES

Main dietary sources are milk, eggs, fish, green leafy vegetables and cereals. Rice is a poor source. Phytic acid in cereals and oxalates in some leafy vegetables decrease the bioavailability of calcium because of formation of calcium phytate and oxalate which are not absorbed.

Phytase destroys phytic acid in wheat during yeast fermentation prior to baking of bread. Calcium hydroxide taken in betel as slaked lime is absorbed and may be an important source of calcium. Drinking water may be another source to some extent.

DAILY REQUIREMENT

Among other elements, copper is associated functionally with iron and is required in very minute quantities, available in normal diet. Cobalt and zinc are also needed in very small amounts. Fluorine prevents dental caries if present in water in a concentration of 1 part per million; when present in excess, it produces symptoms of fluorosis.

Vitamins

Vitamins are organic compounds needed in minute amounts that are essential for health and well-being. They are often grouped as fat soluble (A, D, E and K) and water soluble (B complex and C) vitamins.

FATS SOLUBLE VITAMINS

Vitamin A

It is essential for body growth and for the integrity of epithelial tissues. Dark vision depends upon availability of vitamin A.

Deficiency: Vitamin A deficiency is widely prevalent in India. The symptoms are:

- Retardation of growth.
- Keratomalacia, xerophthalmia and Bitot's spots.
- Night blindness.
- Drying and roughness of skin and drying of mucous membranes.

Sources:

- Animal fats contain large amounts of vitamin A. Good animal sources include butter, ghee, whole milk, egg yolk, liver, fish, etc. Fish liver oils are very rich in vitamin A.
- Green and yellow pigments of plants, called carotenes (*provitamin A*), are converted into vitamin A in the body. Leafy vegetables such as spinach, cabbage, lettuce, curry and radish leaves; yellow pumpkin; and fruits such as mangoes, papaya, tomatoes and oranges are rich in carotene. The amount of carotene in a fruit or vegetable is roughly proportional to the deepness of its green or yellow color.

Vitamin A is destroyed on exposure to ultraviolet light. Hence vitamin A content is higher in fresh vegetables and fruits. Frying may destroy up to 90% of vitamin A but the loss is much less with other forms of cooking. Though thermostable, it is easily oxidised. The

vitamin A content of human milk, cow milk and eggs varies according to the vitamin A content of food and fodder. Cow ghee contains 20 to 25 units and buffalo ghee 8 to 10 units of vitamin A per ml.

Only 20 to 25% of dietary carotenes are absorbed depending upon the fat content of food. Vitamin A or retinol, on the other hand, is easily assimilable and totally absorbed. One microgram beta carotene is regarded as equivalent to 0.25 microgram retinol when assessing the vitamin A content of foods.⁶ Recommended daily allowance is 600 mg retinol for an adult but 950 mg for a lactating mother.⁵ 1 microgram of vitamin A is equal to 10/3 or 3.33 IU.

Vitamin D

It increases calcium and phosphate absorption from the intestine and helps in calcification of bones and teeth. Its deficiency causes osteomalacia in adults and rickets in children.

Sources:

- Cod, halibut, and shark liver oils are rich sources. Among natural foods, it is present in milk, eggs, meat, butter and animal fat. It is not found in plants.
- Ultraviolet light from sun irradiates a lipid substance in the skin known as 7-dehydrocholesterol to form vitamin D. This source can supply nearly all the requirement in adults and children. Clothes, glass and fog obstruct ultraviolet light and interfere with the formation of vitamin D.

Calciferol is the most common synthetic preparation of vitamin D, used in the treatment of osteomalacia and rickets. Margarine and vanaspati are routinely enriched with synthetic vitamins A and D.

Requirements: ICMR has not suggested any RDA for vitamin D because even five minutes exposure to sunlight is sufficient to supply adequate amounts, thus explaining the rarity of rickets in India.⁵ In specific situations associated with minimal exposure to sun, dietary supplementation with 400 IU is recommended. 1 mg of calciferol contains 40,000 IU. Excess of vitamin D is toxic and causes calcification of tissues.

Vitamin E

Germ of cereals, wheat germ oil, soybean, cotton seed oil, corn oils, green leaves and milk are good sources of vitamin E. Its function are not well-defined but it is presumed to prevent sterility and helps in the embedding of ovum. It possesses antioxidant properties. One International Unit of vitamin E is the activity contained in 1 mg of d-alpha tocopherol. Average requirement is 32 IU.

Vitamin K

Vitamin K is fat soluble and is widely distributed, especially in green leafy vegetables and cauliflower. It is thermostable. Natural vitamin K deficiency does not occur. Gut flora are capable of manufacturing vitamin K and thus constitute an additional source.

Water Soluble Vitamins

VITAMIN B COMPLEX

The vitamin B complex is a group of water soluble substances which include thiamine (B₁), riboflavin (B₂), niacin (B₃), pantothenic acid, pyridoxine (B₆), folic acid and cyanocobalamin (B₁₂). They have diverse composition, functions, and deficiency symptoms.

Thiamine (Vitamin B₁)

It was formerly known as anti-beriberi vitamin because its deficiency caused beriberi, a condition now seen rarely. It is present in large amounts in wheat and rice germ, outer layers of cereals, yeast, unmilled pulses and nuts, especially groundnuts. Meat, fish, eggs, milk, vegetables and fruits are relatively poor sources.

Functions: Thiamine is essential for proper carbohydrate metabolism. In its absence or deficiency, carbohydrate breakdown does not proceed fully and pyruvic acid accumulates in the tissues. Carboxylase is needed for decarboxylation and oxidation of pyruvate but carboxylase can act only in the presence of its coenzyme, which happens to be the pyrophosphate of thiamine. Since nervous tissue is almost entirely dependent upon carbohydrate for its energy needs, the ill-effects of thiamine deficiency are particularly noticeable in the form of dry beriberi, peripheral neuropathy and Wernicke's encephalopathy.

Daily allowance: According to recommendations of the ICMR⁵ daily intake should be 0.5 mg per 1000 kcal. In terms of total daily intake, the recommended allowance will vary between 1 and 2 mg depending upon the total energy intake commensurate with age, sex and level of physical activity. In case a large proportion of total energy intake is derived from fats, the thiamine requirements will be correspondingly decreased.

About 25% vitamin B is lost in ordinary cooking since it is readily soluble in water. Large amounts may be lost if too much water is used for cooking rice or vegetables and the excess water is discarded. Thiamine can withstand high temperature, nearly up to boiling point, but only if the medium is slightly acidic (as while baking with yeast). If baking powder or soda is used for cooking, almost all thiamine may be lost.

Dietary sources of thiamine: Rich sources of thiamine include whole grain cereals, nuts, legumes, green leafy

vegetables, organ meats, pork, liver and eggs. As the vitamin is water-soluble and heat labile in alkaline solutions, considerable amounts (about 40-50%) are lost during cooking.

Hard milling causes considerable loss by damage to pericarp and germ of cereals; parboiling of rice conserves this vitamin.

Riboflavin (Vitamin B₂)

Riboflavin is concerned with biological oxidative processes and its deficiency causes metabolic impairment. It is thermostable but is destroyed on exposure to sunshine. Good dietary sources are green leafy vegetables, milk, eggs and liver. Cereals and pulses contain 0.1 to 0.3 mg per 100 gm. Green leafy vegetables in tropical countries contain more riboflavin than in temperate regions. Riboflavin content of some leafy vegetables is—amaranth 0.3, beet greens 0.56, turnip greens 0.57, carrot leaves 0.37, colocasia leaves (black) 0.45, mint 0.26, radish leaves 0.47, and spinach 0.26 mg/10 gm. Cow milk, egg and liver contain 0.19, 0.4 and 1.7 mg percentage respectively.

The recommended daily intake according to ICMR is 0.6 mg/1000 kcal. In absolute terms, this corresponds to an intake of 1 to 2.3 mg/day in various age and sex groups.

However, a minimum intake of 1.2 mg/day is recommended even if the calorie intake is lower than 2000 kcal.

ICMR recommended additional 0.3 mg of riboflavin intake during pregnancy and 0.3 to 0.4 mg during lactation.

Deficiency symptoms may be oral (angular stomatitis and glossitis), dermal (scaly desquamation of nasolabial folds and scrotal dermatitis) and ocular (vascularization of cornea).

Niacin or Nicotinic Acid (Vitamin B₃)

This is one of the most stable vitamins. In body, it occurs in the form of niacinamide or nicotinamide. Niacinamide is a component of the respiratory coenzyme NAD.

Niacin is widely distributed in plant and animal foods, though in small amounts. Particularly rich sources are meat (especially organs), fish, cereals and pulses. The approximate niacin content of some foods (mg/100 gm edible portion) is as follows:⁵

Millets	2
Rice (lightly milled)	3
Rice (highly milled)	1.5
Wheat flour (whole meal)	5
Pulses	2
Fish	4
Mutton	4
Organs (liver, kidney)	12

Whole maize contains 1.5 to 2 mg/100 gm but it is biologically unavailable, being in the bound form.

Niacin is also derived from the essential amino acid tryptophan. In well nourished individuals 60 mg tryptophan is taken as equivalent to 1 mg niacin. While computing dietary intake of niacin, tryptophan contribution as niacin equivalents is added to that of preformed niacin/ nicotinic acid as follows:

Niacin equivalent in mg = (Niacin mg + Tryptophan mg/60)

WHO has recommended daily intake of 6.6 mg niacin equivalents per 1000 kcal for adults, and this holds good for Indian subjects also.⁵ A high leucine: isoleucine, ratio, as in Jawar or maize based diets, impairs the conversion of tryptophan to niacin.⁵

Deficiency symptoms classically manifest as pellagra, seen in some parts of Maharashtra and other areas where sorghum (jawar) is used as staple food. Pellagra is characterized by soreness of tongue, pigmented scaly skin and diarrhea. The dermatitis is symmetrical and mainly affect the exposed parts of the body, such as the back of hands and feet.

Pantothenic Acid (Vitamin B₅)

It is thermostable and is found in all living tissues. Its deficiency is rare.

Pyridoxine (Vitamin B₆)

It exists in three forms as pyridoxal, pyridoxamine, and pyridoxine, which are interchangeable. Vitamin B₆ is needed for important pathways like gluconeogenesis, synthesis of neurotransmitters like serotonin dopamine, taurine, -aminobutyric acid, norepinephrine and histamine. Along with folic acid, vitamin B₁₂ and riboflavin, vitamin B₆ is needed for the metabolism of homocysteine. It is thermostable. Its main dietary source are liver, meat, wheat germ, yeast, legumes and rice polishings. Pyridoxine is essential for normal protein metabolism. It plays a role in the conversion of tryptophan into nicotinic acid. It is also concerned with metabolism of essential fatty acids.

The clinical signs and symptoms of pyridoxine deficiency include peripheral neuritis, epileptiform convulsions, anemia, glossitis, and seborrheic dermatitis. Since these signs and symptoms are seen in other B-vitamin deficiencies as well, it is difficult to assess the magnitude of clinical pyridoxine deficiency in population. Deficiency in infants is associated with neurological symptoms and abdominal distress.

ICMR has recommended intake of 2.0 mg/day for adult individual. Depending upon age and sex of individual the daily requirement of pyridoxine varies between 0.9 and 2.5 mg/day. Additional allowances have been recommended during pregnancy and lactation.⁵

Folic Acid

It helps in the formation of white blood cells and in the maturation of normoblasts to red blood cells. Its defi-

ciency causes megaloblastic anemia and may also lead to tropical sprue. Rich sources are pulses, green leafy vegetables, liver, kidney, yeast and milk. The recommended daily allowance is 200 micrograms for adults. The RDA is 500 micrograms in pregnant women and 300 micrograms during lactation.⁵

Cyanocobalamin (Vitamin B₁₂)

It is a thermostable vitamin found in liver, milk, eggs and meat. It is prepared commercially as a by-product of streptomycin in antibiotic drug industry. It plays an important role in the formation of DNA, especially in the rapidly multiplying cells of bone marrow and gastrointestinal epithelium. It also acts as a coenzyme in amino acid metabolism and maintains the nutrition of nerve cells. Its deficiency causes macrocytic anemia.

In addition, neurological manifestations due to sub-acute combined degeneration of spinal cord or demyelination of nerve fibers may also occur.

Daily requirement is small, the recommended allowances being 1 mg (1.5 in lactation).

Though vitamin B₁₂ is totally absent from plant foods, its deficiency in vegetarians is not as high as would be expected. The reasons are as follows:

1. Milk, which is consumed by most vegetarians, is a moderately rich source, providing 0.14 mgm/100 ml.⁶
2. Pulses contain some vitamin B₁₂ because the root bacteria in leguminous plants manufacture vitamin B₁₂.
3. Contamination of food and water by bacteria, moulds, insects and fecal matter, etc. provides small amounts of this vitamin.

VITAMIN C (ASCORBIC ACID)

It is the most unstable vitamin, being easily destroyed by heat. It is easily susceptible to atmospheric oxidation. Dry and stale vegetables and fruits become markedly depleted in vitamin C. Citrus fruits, tomatoes, cabbage, green leafy vegetables fresh fruits, germinating and sprouting pulses and cereals are rich in vitamin C. Fresh meat and milk also contain small amounts.

The recommended daily allowance is 40 mg for adults (80 mg during lactation).

Functions

- It is essential for formation and maintenance of intercellular cement substance, lack of which leads to hemorrhages, delayed healing and poor formation of scar.
- It is necessary for growth and maturation of red cells. It converts folic acid into folinic acid.
- It maintains functional status of adrenal cortex.

Deficiency of vitamin C leads to scurvy which is rare nowadays. Delayed healing of wound, bleeding gums and hemorrhages from mucous membranes are early symptoms.

Food and Food Groups

Foods are often grouped according to their origin as follows:

Animal Foods

- Milk and milk products
- Eggs, meat and fish.

Vegetable Foods

- Cereals and millets
- Pulses, oil seeds and nuts
- Vegetables: Leafy, non-leafy and starchy
- Fruits
- Fats and oils
- Sugar, jaggery and honey
- Spices and condiments
- Beverages.

CLASSIFICATION OF FOODS BASED ON FUNCTION

Energy Rich Foods

These include carbohydrates and fats. Following are some examples.

- Whole grain cereals, millets
- Vegetable oils, ghee, butter fat soluble vitamins, essential fatty acids
- Nuts and oilseeds.

Body Building Foods

Includes proteins:

- Pulses, nuts and oilseeds
- Milk and milk products
- Meat, fish, poultry

Protective Foods

Vitamins and minerals:

- Green leafy vegetables
- Other vegetables and fruits
- Eggs, milk and milk products and flesh foods.

Milk and Milk Products (Table 22.5)

MILK

Milk is an ideal food for infants and children and a good supplementary food for adults. Its per capita consumption was estimated to be 600 ml and 108 ml in England and India respectively in early 70's. More recent data reveal an average daily milk intake of 70 ml in rural areas in India compared to a daily recommended intake of 150 ml for adults.⁶ In rural areas, milk intake was less than the recommended intake of 150 ml in all states surveyed by the NNMB (National Nutrition Monitoring Bureau) except Gujarat, where the daily intake was 267 ml per consumption unit per day. The lowest level of 20 to 30 ml per day was seen in Orissa and West Bengal. As regards urban areas, the middle and high income groups consume more than the recommended quantity of milk, while the consumption in slum areas is about one-third of the RDA.¹²

Composition of Cow's Milk (Table 22.6)

Cow milk contains 3.5% protein, of which casein accounts for 3 gm%, lactalbumin 0.4 gm% and lactoglobulin 0.1 gm%. All the three have high biological values. It may be mentioned that when milk is heated, only lactalbumin and lactoglobulin get precipitated. Casein is held in solution by calcium phosphate in the form of calcium caseinogenate. The latter gets coagulated during the process of curd formation.

TABLE 22.5: Nutritive value of milk and milk products per 100 gm

Products	Moisture g	Proteins g	Fat g	CHO g	Minerals g	Calcium mg	Vit A iu	Energy kcal
Milk								
Human	88	1.1	3.4	7.4	0.1	28	137	65
Cow's	87.5	3.2	4.1	4.4	0.8	120	174*	67
Buffalo's	81.0	4.3	6.5	5.0	0.8	210	160	117
Goat's	86.8	3.3	4.5	4.6	0.8	170	182	72
Skimmed milk	92.1	2.5	0.1	4.6	0.7	120	—	29
Milk powder								
Skimmed milk powder (cow's)	4.1	38.0	0.1	51.0	6.8	1370	0	357
Whole milk powder (cow's)	3.5	25.8	26.7	38.0	6.0	950	1400	496
Channa (buffalo's)	54.1	13.4	23.0	7.9	1.6	480	—	292
Cheese	40.3	24.1	25.1	6.3	4.2	790	273	348
Khoa or mawa (buffalo's)	30.6	14.6	31.2	20.5	3.1	650	—	421

* Also contains, in addition, 6 microgram carotene

TABLE 22.6: Boiling vs pasteurization

Pasteurization	Boiling
<p>Bacteriological changes All pathogens are killed at 63°C and acid forming bacilli are reduced, thus delaying lactose fermentation</p> <p>Chemical changes</p> <ul style="list-style-type: none"> The proportion of insoluble calcium is increased by 6% Other minerals are not affected Iodine is reduced by 20% Lactose is slightly changed or caramelised but there is no change in the taste Scum is not formed, hence calcium and phosphorus are not affected Only 5% loss of lactalbumin, as it coagulates at 70°C <p>Nutritional changes Vitamin C is reduced. Other vitamins are not affected</p>	<p>All pathogens and acid-forming bacilli are killed, hence no fermentation or souring occurs. Keeping quality is thereby improved</p> <p>Calcium and magnesium phosphates are precipitated by boiling. Iodine is totally lost Lactose is caramelised (semi-burnt) and the taste is altered Calcium and phosphorus are taken up by the scum or pellicle that forms on the top Lactalbumin and lactoglobulin undergo coagulation</p> <p>Vitamin C is lost considerably or totally. Other vitamins are reduced to variable extent</p>

Cal. caseinogenate + lactic acid = casein + calcium lactate.

Fats are present in emulsion as glycerides of fatty acids, mainly butyric, oleic, stearic and palmitic acids. Milk fat is easily digestible.

Carbohydrate is present in milk as lactose. On fermentation, it is converted into lactic acid by *Lactobacillus lactis*; the acid coagulates casein, forming curd.

Milk contains most vitamins and all minerals but vitamin C and iron are present only in very small quantities. It is a rich source of assimilable calcium.

Adulteration of Milk Products

Adulteration of milk may be defined as addition of any material to the milk, or removal of any constituent of milk. The common adulterants in milk include addition of water, sugar, cereal flour, skim milk powder, gelatin, urea, etc. and removal of fat. The water adulterated milk tests less lactometer reading and less solid not fat content (SNF). Adulteration of milk is a punishable offence under the Prevention of Food Adulteration Act (**PFA Act, 1954**). The PFA standards, which are mandatory, prescribe minimum compositional standards, standard for levels of residues of chemical contaminants and various other provisions. **The Milk and Milk Products Order, 1992** sets sanitary requirements for dairies, machinery, and premises, and includes quality control, certification, packing, marking and labeling standards for milk and milk products.

Milk Hygiene

Milk is an efficient vehicle for a great variety of disease agents. The sources these infection may be (i) the dairy of animal (ii) the human handler or (iii) the environment, e.g. contaminated vessels, polluted, water, flies, dust, etc. Following factors should be taken into consideration production processing and distribution of milk and milk product.

- Animal must be healthy and clean;
- Premises where the animal is housed and milked must be sanitary
- The milk vessels must be sterile and kept covered
- The water supply must be safe
- Milk handlers' must be free from communicable diseases
- Milker must wash their hands and arms before milking
- Strict control of milk and milk product processing
- The distribution of milk must be done under hygienic condition.

Milk Standards

Detailed food standards have been prescribed under the Prevention of Food Adulteration Act, 1954, for milk and milk products. Some of these are given below.

- Cow milk:** It should not contain less than 3.5% of milk fat. Solids not fat (nonfat solids) should not be less than 8.5%.
- Buffalo milk:** Milk fat at least 6% and solids not fat 9%.
- Skimmed milk:** Solids not fat at least 8.5%.
- Toned milk:** Fat 3%, solids not fat 8.5%.
- Dahi:** Standards are same as for the milk from which it is prepared.
- Khoa:** Fat 20%. Should not contain any ingredient other than those in milk.
- Icecream:** Fat 10%, total solids 36%.
- Cream:** Fat 23%, no added substance.

Milk Borne Diseases

Diseases which can be directly transmitted through milk are brucellosis, Q fever and anthrax. However, contaminated milk can also act as a vehicle for other pathogens and can be responsible for enteric fever, food poisoning and diphtheria.¹³ Dysentery, diarrhea, and, potentially, even poliomyelitis and infective

hepatitis might be transmitted through infected milk. There is no evidence for occurrence of bovine tuberculosis in India.

Pasteurization

It is a process by which milk is made free from all pathogens, including tubercle bacillus, which is killed at 63°C. Most nutrients are preserved during pasteurization. There are two methods.

1. *Holding or holder process*: This is the British method in which milk is heated to and maintained at a temperature of 65.5°C or 150°F for half an hour. Then it is cooled down to 50°F or 10°C. It is a slow method.
2. *Flash process or high temperature short time process (HTST)*: This American method is fairly quick. Milk is heated to 71° or 72°C, kept at this temperature for 15 seconds, and then suddenly cooled to 10°C.

Sterilization by boiling. It is a common practice in India to boil milk. Boiling and pasteurization are compared in **Table 22.6**.

MILK PRODUCTS

- *Cheese*: It is a nutritious food consisting mainly of protein (24.1%) and fat (25.1%).
- *Butter*: It consists of 81% fat, a trace of protein, 2.5% minerals and 16 to 20% water. It is rich in vitamins A and D.
- *Ghee*: It is clarified butter with less than 0.5% moisture.
- *Butter milk*: It is the product obtained after removal of butter from curds by churning.

Eggs and Meat

EGGS

An average hen's egg weighs 50 gm. It consists of 3 parts:

1. Shell, 12% by weight.
2. White, 58% by weight, consisting mainly of albumin.
3. Yellow, 30% by weight consisting mainly of lecithin, a phospholipid in finely emulsified form and vitellin, a phosphoprotein.

Egg contains 13.3% protein, 13.3% and 73.7% water. Its energy value is 173 kcal per 100 gm. Its calcium and iron contents are 60 and 2.1 mg per 100 g respectively. Consumption of raw egg may lead to infection with *Salmonella* organisms. Boiling destroys these germs and inactivates avidin (a potent antibiotic factor) as also a trypsin inhibitor found in raw egg white. Egg can be preserved by blocking the pores in the shell. This is done by smearing the egg with oil or grease, or by immersing it in a solution of sodium silicate (glazing). This prevents bacteria from entering the egg.

Tests for Freshness

- *Candling*: An egg is translucent when sunlight or electric light is passed through it. A spoiled egg is opaque and if there is gas, it is transparent. When held against light, the yellow is seen floating in the white in a fresh egg.
- A fresh egg sinks in 10% saline or water and remains in horizontal, not a tilted or vertical position. If decomposed, it floats.

MEAT

The term meat includes all flesh foods such as beef, pork, mutton, poultry, liver, etc.

General Composition

Muscle proteins consist mainly of myosin and small amounts of albumin and myoglobin. Some meats such as pork are rich in fat. Meats, in general, are rich in vitamin B₂, iron and protein (**Table 22.7**).

Consumption of infected meat may lead to various diseases. The more important meat borne diseases are brucellosis, anthrax, food poisoning and infection by helminths like *Taenia solium*, *T. saginata* and *Trichinella spiralis*.

Cereals and Millets

In India, cereals like wheat, rice and maize form the staple food of people. Millets (smaller grains that are eaten without removing the outer layer) are also used to a fair extent by some segments of the population. More common among the millets are jawar and bajra. Ragi and kodri are also used by the poor.

Cereals and millets are rich in carbohydrates. Being the staple food, they form the major source of dietary protein. They are a good source of minerals and several B complex vitamins.

WHEAT

It contains more protein than any other cereal (12%), but is deficient in lysine which is made up by eating chapatis with legumes. When milled whole wheat flour is sieved, about 5% bran is removed and the remaining flour of 95% extraction (atta) is used for making chapatis. On straining through cloth, about 10% is removed and the remaining refined flour of 90% extraction (maida) is used for making bread. Highly refined flour is poorer in proteins, minerals and vitamins. The high extraction wheat flour is fortified in the western countries with calcium and thiamin to make up for the loss. Semolina (suji), prepared from the outer part of wheat, is richer in minerals and vitamins and is used for making puddings. Wheat flour contains gluten, a

TABLE 22.7: Nutrient value of different meats per 100 gm

Name of food stuffs	Protein gm	Fat gm	CHO gm	Minerals gm	Vit A iu	Thiamine mg	Moisture gm	Energy kcal
Beef (muscle)	22.6	2.6	—	1.0	18	0.15	74.3	114
Fowl	25.9	0.6	—	1.3	—	—	72.2	109
Liver, sheep	19.3	7.5	1.3	1.5	690	0.36	70.4	150
Mutton (muscle)	18.5	13.3	—	1.3	9	0.18	71.5	194
Pigeon	23.3	4.9	—	1.4	—	—	70.4	137
Pork (muscle)	18.7	4.4	—	1.0	0	0.54	77.4	114
Fish (pomfret)	17.0	1.3	1.8	1.5	—	—	78.4	87

sticky protein that makes the dough spongy and stretchable. Maida is rich and suji is poor in gluten.

RICE

The grain consists of three parts—embryo, endocarp and pericarp. The pericarp and embryo contain most of the protein, fat, minerals and vitamins. The endocarp mainly contains starch. The protein content of rice is 6 to 8.5 per cent. Though rice contains less protein than wheat, rice protein is qualitatively better than wheat protein.

The nutrient value of rice depends on the way the husk is removed. Hard milling removes a good part of pericarp along with husk (**Fig. 22.1**). This reduces the nutrient value. Undermilling and hand pounding are less damaging. Nutrient loss can be minimized by parboiling of rice. In this process, rice is soaked in water for 2 to 3 days, boiled or steamed, dried and then dused by hand or machine. As a result of parboiling, the nutrient rich outer layer (Pericarp) sticks to the endocarp and some nutrients diffuse into the latter. The color and odour are improved if paddy is soaked in water at 65 to 67° for 2 to 3 hours only instead of in cold water for 2 to 3 days. Parboiled rice is harder than ordinary rice but is less vulnerable to nutrient loss during cooking.

MAIZE OR CORN

It is deficient in lysine and tryptophan. Pellagra, due to niacin deficiency, may be found in areas where maize is the staple food.

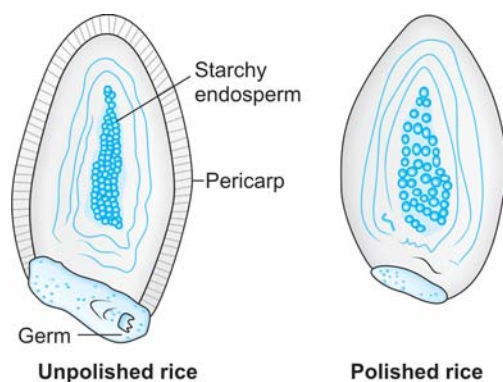


Fig. 22.1: Unpolished rice and polished rice

Pulses, Oil Seeds and Nuts

PULSES (LEGUMES)

Pulses include grams, peas, lentils and beans. They contain globulin and a protein called legumin. In combination with cereals, they form a good source of all essential amino acids. The protein content of pulses is 20 to 22% in general. They supply good amounts of iron and calcium, as well as thiamine and riboflavin.

Khesari dal (Lathyrus sativus): If taken for a long time, it gives rise to lathyrism characterized by spastic paralysis of lower limbs. The symptoms are due to toxic factor in dal called Beta oxalyl alpha amino oxidase (BOAA). This cheap dal is mainly consumed by poor people in Madhya Pradesh. The toxic principle can be removed by parboiling.¹⁴ Efforts are being made to develop toxin free strains of *Lathyrus sativus*.

OILSEEDS AND NUTS

Oilseeds and nuts are grouped with pulses because, like them, they are a rich source of protein. Oil seeds, except gingelly or sesame (til), are not consumed as such. Oil is extracted from them and the oil cake rich in protein is fed to cattle. Nuts, on the other hand, are taken as such. They are rich in protein and fat.

Groundnut (Peanut)

It has high caloric value and is rich in fat (40%), protein (25%) and vitamins B₁, B₂ and nicotinic acid. The protein lacks in lysine, which can be supplemented by eating groundnut with Bengal gram. The protein rich multipurpose food, prepared by Central Food Technological Research Institute, Mysore, contains Bengal gram and defatted groundnuts in a ratio of 1:3 with added vitamins. Its carbohydrate, fat, protein and total energy content per 100 gm are 35.8 gm, 8.5 gm, 41.9 gm and 387 kcal respectively (**Table 22.8**).

Groundnuts may be infested with a mould *Aspergillus flavus*, especially the old stocks stored under unfavorable circumstances. The mould is found to be toxic to lower animals. The toxins have been identified as aflatoxins. There is some evidence that aflatoxins especially aflatoxin B₁, are hepatotoxic in man.

TABLE 22.8: Nutrient value of cereals, pulses, oilseeds and nuts per 100 gm

Food stuff	Protein gm	Fat gm	CHO gm	Minerals gm	Vitamin B ₁ mg	Vitamin B ₂ mg	Energy kcal
<i>Cereals</i>							
Wheat atta	12.1	1.7	69.4	2.7	0.49	0.17	341
Maida	11.0	0.9	73.9	0.6	0.12	0.07	348
Rice							
raw (milled)	6.8	0.5	78.2	0.6	0.06	0.06	345
parboiled (hand pounded)	8.5	0.6	77.4	0.9	0.27	0.12	349
Maize, dry	11.1	3.6	66.2	1.5	0.42	0.10	342
Jawar	10.4	1.9	72.6	1.6	0.37	0.13	349
Bajra	11.6	5.0	67.5	2.3	0.33	0.25	361
Barley	11.5	1.3	69.6	1.2	0.47	0.20	336
Oat	13.6	7.6	62.8	1.8	0.98	0.16	374
Ragi	7.3	1.1	72.0	2.7	0.42	0.11	328
<i>Pulses</i>							
Bengal gram Dal	20.8	5.6	59.8	2.7	0.48	0.18	372
Black gram Dal	24.0	1.4	59.6	3.2	0.42	0.20	347
Green gram (whole)	24.0	1.3	56.7	3.5	0.47	0.27	334
Lentil	25.1	0.7	59.0	2.1	0.45	0.20	343
Rajmah	22.9	1.3	60.6	3.2	—	—	346
Redgram	22.3	1.7	57.6	3.5	0.45	0.19	335
Soybean	43.2	19.5	20.9	4.6	0.73	0.39	432
<i>Oil seeds and nuts</i>							
Almonds	20.8	58.9	10.5	2.9	0.24	0.57	655
Cashewnut	21.2	46.9	22.3	2.4	0.63	0.19	596
Coconut dry	6.8	62.3	18.4	1.6	0.08	0.01	662
Sesame (til) seeds	18.3	43.3	25.0	5.2	1.01	0.34	563
Groundnut	25.3	40.1	26.1	2.4	0.90	0.13	567
Linseeds	20.3	37.1	28.9	2.4	0.23	0.07	530
Walnut	15.6	64.5	11.0	1.8	0.45	0.40	687

Vegetables

Vegetables form an important part of daily diet. They fall into three groups—leafy, non-leafy, and starchy.

LEAFY VEGETABLES

They are cheap protective foods, being rich in minerals like calcium and iron and vitamins like vitamin A (carotene), vitamin C, riboflavin and folic acid. It is to be noted that green leafy vegetables can also be a fairly good source of protein. This is so for two reasons. Firstly, the biological value of leaf proteins is quite high. Secondly, though the protein content of fresh leafy vegetables is low, it is so because of the relatively high water content. This means that dried green leafy vegetables can be a rich source of protein. For example, the protein content of fresh and dried colocasia leaves is 3.9% and 13.7% respectively.⁶ Similarly, the values for fenugreek leaves are 4.4% and 19.5% respectively.

NON-LEAFY VEGETABLES

They include gourds, bringal (bengan), lady finger (bhindi), tomato, cauliflower, pumpkin, carrot, turnip, radish, etc. (Their leaves in addition, may also form a part of diet). Their carbohydrate content is low (3 to 8%) as compared to starchy vegetables.

STARCHY VEGETABLES

They include roots and tubers like beet, potato, sweet potato, colocasia (ari), yam and tapioca. They are rich in starch. Most of them are fair sources of vitamin C. Nutrient values of some vegetables are given in **Table 22.9**.

Fruits

Fruits in unripe state are sour because they contain certain acids (tartaric acid in grape and tamarind, citric in tomato, lemon, orange and mango, malic acid in apple). On ripening, the acids are converted into sugars (fructose and sucrose) and the fruits become sweet. Fresh fruits, specially citrus fruits, are good source of vitamin C. Guava and Indian gooseberry (amla) are rich sources of vitamin C. Papaya, mango and other yellow fruits are rich in carotene.

Most fruits have laxative action because of high fiber content. About 30 to 40 gm fruits should be included in daily diet according to the season.⁶ It is not necessary to eat costly fruits. In spite of their palatability, the nutritive value of fruits is low. They mainly provide vitamin C, which, of course, can be obtained from vegetables, especially the leafy ones. Nutrient values of some fruits are given in **Table 22.9**.

TABLE 22.9: Nutrient values of vegetables and fruits per 100 gm

Name of foodstuff	CHO gm	Protein mg	Ca mg	Fe mg	Vitamin B ₁ mg	Vitamin B ₂ mg	Energy kcal
<i>Leafy vegetables</i>							
Bathua	2.9	3.7	150	4.2	0.01	0.14	30
Cabbage	4.6	1.8	39	0.8	0.06	0.09	27
Coriander leaves	6.3	3.3	184	1.42	0.05	0.06	44
Lettuce	2.5	2.1	50	2.4	0.09	0.13	21
Fenugreek leaves	6.0	4.4	395	1.93	0.04	0.31	49
Rape leaves	5.9	5.1	370	12.5	0.01	0.03	48
Spinach	2.9	2.0	73	1.14	0.03	0.26	26
Ash gourd	1.9	0.4	30	0.8	0.06	0.01	10
Bitter gourd	4.2	1.6	20	0.61	0.07	0.09	25
Brinjal	4.0	1.4	18	0.38	0.04	0.11	24
Calabash cucumber (Bottle gourd)	3.5	0.2	20	0.46	0.03	0.01	12
Cluster beans	10.8	3.2	130	1.08	0.09	0.03	16
Cucumber	2.5	0.4	10	0.60	0.03	0.00	13
Drumstick	3.7	2.5	30	0.18	0.05	0.07	26
Knol-khol	3.8	1.1	20	1.54	0.05	0.09	21
Ladies fingers	6.4	1.9	66	0.35	0.07	0.10	35
Pumpkin	4.6	1.4	10	0.44	0.06	0.04	25
Rhubarb stalks	4.3	1.1	120	2.2	—	—	26
Carrot	10.6	0.9	80	1.03	0.04	0.02	48
Colocasia	21.1	3.0	40	0.42	0.09	0.03	97
Onion, big	11.1	1.2	47	0.60	0.08	0.01	50
Potato	22.6	1.6	10	0.48	0.10	0.01	97
Radish, white	3.4	0.7	35	0.4	0.06	0.02	17
Sweet potato	28.2	1.2	46	0.21	0.08	0.04	120
Turnip	6.2	0.5	30	0.4	0.04	0.04	29
<i>Fruits</i>							
Apple	13.4	0.2	10	0.660	—	—	59
Apricots, fresh	11.6	1.0	20	2.2	0.04	0.13	53
Banana, ripe	27.2	1.2	17	0.36	0.05	0.08	116
Ber (<i>Zizyphus</i>)	17.0	0.8	4	0.50	0.02	0.05	74
Dates, fresh	33.8	1.2	22	0.96	—	—	144
Grapes (pale green)	16.5	0.5	20	0.52	—	—	71
Guava, country	11.2	0.9	10	0.27	0.03	0.03	51
Lemon	11.1	1.0	70	0.26	0.02	0.01	57
Musambi (sweet lime)	9.3	0.8	40	0.7	—	—	43
Malta (sweet lime)	7.8	0.7	30	1.0	—	—	36
Mango, alphonso							
Melon (musk)	3.5	0.3	32	1.4	0.11	0.08	17
Orange	10.9	0.7	26	0.32	—	—	48
Orange juice	1.9	0.2	5	0.7	0.06	0.02	9
Papaya ripe	7.2	0.6	17	0.5	0.04	0.25	32
Pears	11.9	0.6	8	0.5	0.06	0.03	52
Pineapple	10.8	0.4	20	2.42	0.20	0.12	46
Pomegranate	14.5	1.6	10	1.79	0.06	0.10	65

Sugar, Jaggery and Honey

Sugar (khand), jaggery (gur), and brown sugar (shakkar) prepared from sugar cane are used as sweetening agents in daily diet in many different ways. Honey, palm sugar, maple sugar and beet sugar are also used to some extent. The refined cane sugar contains 99.4% of sucrose and is devoid of vitamins and minerals. Jaggery and brown sugar also contribute to Ca, Fe and vitamin B needs of the body to some extent. Excessive use of sugar causes dental caries.

Condiments and Spices

According to Taber's medical dictionary, condiments are appetising ingredients added to food and are classified as follows:

Aromatic: Vanilla, cinnamon, cloves, parsley.

- Acrid : Pepper, ginger
- Alliaceae (allylic) : Onion, garlic, mustard, horse radish
- Acidic : Vinegar, citron
- Animal origin : Caviar, anchovies
- Miscellaneous : Salt, sugar

As defined by Webster's dictionary, spices are pungent or aromatic substances of plant origin that are used for seasoning or preservation of food, such as pepper, cinnamon and cloves (**Table 22.10**).

The condiments and spices have little nutritional value as such since their energy, protein, vitamin or mineral content is negligible. Their main importance lies in the fact that they improve taste and flavor and increase appetite as well as the secretion of digestive

TABLE 22.10: Fatty acid composition of common edible fats and oils (expressed as percentage of total)

Substance	Saturated*	Monoun-saturated**	Polyunsa-turated***
Coconut oil	87.9*	7.8	0.8
Corn oil	12.7	24.6	57.4
Cotton seed oil	25.9	22.9	47.8
Groundnut oil	20.9	48.3	29.9
Mustard or Rape seed oil	10.7	9.5	32.6
Olive oil	14.2	71.5	8.2
Palm oil	47.9	37.9	9.0
Palmolin	47.7	41.4	10.6
Rice bran oil	19.5	39.2	33.3
Sunflower oil	10.7	17.7	78.5
Sesame oil	13.4	41.3	44.5
Soyabean oil	13.1	28.9	57.2
Sunflower oil	9.1	25.1	66.2
Butter	49.8	20.1	1.8

* Palmitic, stearic, arachidic, biethnic and lignoseric

** Palmitolic and oleic

*** Linoleic and linolenic

juices. Some condiments and spices have been shown to possess specific physiological action. For example, garlic and asafoetida have been shown to reduce the total count of bacterial flora and thus to prevent flatulence.¹⁵ Garlic is now well known to have hypocholesterolemic action. Turmeric and cumin have been shown to possess antiinflammatory and galactagogic properties respectively. Excessive use of spices, particularly red chillies, may cause gastric mucosal damage and predispose to gastric or even peptic ulcer.

Beverages

Beverages are drinks used as food accessories.

TEA

Tea leaves contain 2 to 5% caffeine, a stimulant; 5 to 12% tannic acid, an astringent; traces of theophylline; and some volatile essential oils. Tea is rich in fluorine.

Tea is used all over the world. Its nutritional value is doubtful. Drinking too much tea can cause gastritis and may even predispose to peptic ulcer. Polyphenols in tea bind nonheme iron in food, thus making it unavailable and predisposing to anemia in vegetarians. Drinking tea with meals decreases iron absorption by 62%.¹⁶

COFFEE

Coffee seeds are roasted and then ground into powder. In this process, tannic acid is destroyed, proteins are coagulated and a pleasant aroma due to an essential oil, caffeol, is liberated. The caffeine content is 0.6 to 2%. Chicory, up to about 20%, is often mixed with caffeine to increase color and flavor.

COCOA

It is prepared by roasting and grinding cocoa beans obtained from the tree, *Theobroma cocoa*. The seeds contain 50% fat, 1.3% theobromine and a little caffeine. The powder is mixed with starch and sugar in order to dilute the fat content.

ALCOHOLIC OR FERMENTED DRINKS

There are innumerable varieties of alcoholic drinks depending upon the type of sugar or yeast used for fermentation. However, all of them contain ethyl alcohol in varying concentration. Beer or malt liquors are prepared from fermented malt (barley) and contain 3 to 7% alcohol. Spirits are prepared by distillation and are extracted from a variety of substances that yield fermentable sugar. They contain variable amounts of alcohol: whisky 47 to 53%, brandy 48 to 54%, rum 50 to 60%, and gin 40 to 50%. Wines are made by fermentation of fruit juice with yeast. Natural wines, such as champagne, have a maximum alcohol strength of 15%. Country liquors are made by fermentation of rice, mahua, molasses or gur. They contain 40% alcohol. Toddy is fermented nira (palm juice) and contains about 5% alcohol.

Preservation of Foods and Conservation of Nutrients

Food Preservation

Three objectives of food preservation are:

1. To keep foods fresh, wholesome and free from contamination.
2. To make foods available when out of season and to avoid wastage when in excess.
3. To supply foods to areas where there is scarcity.

Methods of Preservation

- **Heating and canning:** The food is heated to kill all bacteria. It is then kept in the can and heated again so as to drive out the air from the can, which is then sealed. Vitamin C is reduced in this process but the loss is lesser than that during cooking. Vitamin A stands heat well in the absence of air. Vitamin B₁, B₂, D and E are not destroyed. This is a good method, suitable for many foods such as fish, meat, peas, pineapple, tomato sauce, etc.
- **Drying or dehydration:** This method removes the moisture required for growth of bacteria. It is suitable for milk and biscuits but not for meat. Fruits and vegetables, such as apples and chillies, are exposed to sun for drying.

- **Smoking:** Meat and fish, after salting, are dried and smoked. The organic compounds present in smoke are germicidal. However, the parasites present in meat may not die because the smoke does not penetrate deep.
- **Salting and pickling:** 18 to 25% brine is used for pickling fish and meat. Brine, vinegar or weak acids prevent the growth of germs, though they may not kill them. Pepper, chillies and mustard are used for pickling vegetables. Bacon is highly salted pork.
- **Preparing jams:** Sugar syrup is used. To preserve fruits in the form of jams. It prevents bacterial growth.
- **Cooling and refrigeration:** Cold kills some parasites and reduces the growth of harmful bacteria. Meat, eggs, milk, vegetables, fruits and fish start decomposing when the temperature rises above 10°C. Digestibility and food values are not affected as a result of refrigeration.
- **Gas storage:** CO₂ atmosphere is often used to store fruits and, sometimes, meat.
- **Glazing or coating:** Sodium silicate solution is used to preserve eggs. The method closes the pores in the shell.
- **Addition of chemicals:** Certain chemicals help in preservation. Those permitted are benzoic acid, benzoates, sulphur dioxide and sulphites. Methyl bromide is a widely used fumigant for controlling infestation in foods and agricultural commodities. This is being phased out now because it is an ozone depleting agent.
- **Ionizing radiation:** There was initial controversy regarding safety of irradiated food. Now it is generally agreed that food irradiation is a safe procedure, provided proper guidelines are followed. It is a particularly useful procedure for controlling microorganisms in animal foods like poultry, pork, etc. It is also a preferred substitute for fumigating products meant for export. A recent symposium, held in France, with participation of 40 countries, concluded that irradiation may prove to be one of the most important food technologies for protecting human health since the introduction of pasteurization, a century ago. The Ministry of Health, Govt of India, has already cleared irradiation of potatoes, spices and seafood.

Conservation of Nutrients

Cooking improves the flavor, taste and digestibility of food and helps in removing the harmful organisms. Cooking is both an art and a science and, if done properly, it conserves nutrient values.

GUIDELINES FOR PREVENTING NUTRIENT LOSS DURING COOKING

- Keep all foods dry, clean and airtight. This prevents loss due to moisture, bacterial contamination, insects and rats, etc.
- Ghee, butter, oil, etc. should be kept sealed in a cool and dry place to prevent rancidity.
- Milk should be rapidly brought to boiling point and then cooled quickly, as in pasteurization, to conserve food values. Milk cookers conserve food values better because of indirect steam heating.
- Do not use baking soda since loss of vitamins is more in an alkaline medium.
- Eggs are best cooked below the boiling point.
- Rice should be hand-pounded or under-milled to conserve vitamins, minerals and proteins.
- Pulses, food grains, and vegetables should not be washed repeatedly before cooking. Do not use large quantity of water for boiling and do not throw away the water used for cooking. Pulses should be sprouted or at least soaked for a few hours before cooking.
- Fermentation after sprouting further increases the vitamin content. Rice and gram grains are soaked, ground and fermented overnight to produce the appropriate dough for preparation of idli, dosa, khaman and dhokla. This is a useful practice, since fermentation reduces phytate content and increases thiamine, riboflavin and nicotinic acid content.
- Do not cut vegetables too small and do not discard slender leaves and tender cuttings and gratings. Trimming and peeling should be minimum. Wash vegetables before and not after cutting.
- Do not cook vegetables for more than 15 minutes. Excessive and repeated heating of food should be avoided.
- When cooking vegetables, they should be put straight into boiling water. High temperature will then destroy an enzyme (oxidase) that destroys vitamin C, otherwise vitamin C is destroyed first. Salt should be added late since addition of salt before boiling hastens the loss of nutrients.
- Boil potatoes and sweet potatoes without peeling them. Better still, steam them in a cooker.
- Addition of a little acid such as tamarind, lemon juice, vinegar, citric acid or sour butter milk, while cooking, conserves nutrient values.
- Use of iron knives and cast iron pans adds to the iron content of diet.
- As far as possible, foods should be cooked by steam heating (either direct, such as putting food over a colander in a covered pan, or indirect, when food is kept in a closed container and immersed in boiling water). Loss of nutrients is almost nil during the indirect method, mild during the direct method and

more during open boiling. Cooking in a vessel covered with a lid or in a pressure cooker reduces nutrient loss.

- Both shallow and deep frying of foods in oil causes loss of nutrients. The loss is less in deep frying because the oil coating over the food prevents loss. Sudden high temperature in deep frying causes puffing out of food because of its moisture content. Do not use the same oil or fat for frying repeatedly over a number of days.

Diet Standards and Diet Planning

Diet plays an important role in promotion of health and prevention of diseases. The suitable diet for a community is one that is cheap, conforms to people's habits and customs and provides a balanced intake of nutrients. A nutritionally balanced diet should provide adequate amounts (neither too little, not too much) of various nutrients as per the nutritional requirements. Such requirements depend upon age, sex, weight, height and physical conditions like pregnancy and lactation. To some extent, they may depend upon climate also.

The requirements of various nutrients, except energy, have already been discussed. Ordinarily, a mixed diet consisting of foodstuffs from different food groups is likely to be adequate in protein, vitamins and minerals if it is adequate as regards energy needs. Inadequate calorie intake in the poor and excess intake in the rich create problems of malnutrition. A detailed account of human energy needs will hence be given here.

Food energy is measured in terms of a large calorie or kilocalorie which is equivalent to 1000 standard calories. The heat of combustion of various foods, along with the percent energy bioavailability, is given below¹⁰:

The net values as given in **Table 22.11** are at the water factors which are used for calculating the energy value of carbohydrates, proteins and fats in general.

Reference Indian Adult Man And Woman⁵

Energy intake recommendations are made based on the reference man and women whose profile have been described as follows.

According to Indian standard, the **reference man** is between 18 and 29 years of age and weighs 60 kg with a height of 1.73 m with a BMI of 20.3 and is free from disease and physically fit for active work; on each working day, he is engaged in 8 hours of occupation which usually involves moderate activity, while when not at work he spends 8 hours in bed, 4 to 6 hours in sitting and moving about, 2 hours in walking and in active recreation or household duties.

Reference woman is between 18 and 29 years of age, non-pregnant non-lactating (NPNL) and weighs 55 kg with a height of 1.61 m and a BMI of 21.2, is free

from disease and physically fit for active work; on each working day she is engaged in 8 hours of occupation which usually involves moderate activity, while when not at work she spends 8 hours in bed, 4 to 6 hours in sitting and moving about, 2 hours in walking and in active recreation or household duties.

Energy

The body needs energy for maintaining body temperature and metabolic activity and for supporting physical work and growth. To maintain energy balance, the input must equal the output, which corresponds to a steady state. The energy allowances recommended are designed to provide enough energy to promote satisfactory growth in infants and children and to maintain constant appropriate body weight and good health in adults.

UNITS OF ENERGY

The unit of energy in nutrition has long been expressed as Kilocalories (kcal). However, recently the International Union of Sciences and International Union of Nutritional Sciences (IUNS) have adopted 'Joule' as the unit of energy in the place of kcal. **Joule**, a physical unit of energy, is defined as the energy required to move 1 kg of mass by 1 meter by a force of 1 Newton acting on it.

A kilocalorie (kcal) is defined as the heat required to raise the temperature of one kg of water by 1°C from 14.5°C to 15.5°C. The unit kcal is still popularly used. Both units are used in defining human energy requirement in this report.

The relationship between the two units of energy is as follows:

- 1 kcal = 4.184 kJ (Kilojoule)
- 1000 kcal = 4184 kJ = 4.18 mJ (Mega Joule)
- 1 mJ = 239 kcal.

ENERGY REQUIREMENTS

The energy needs varies with number of factors such as age, sex, body size, physical activity and, climate and altered physiological status such as pregnancy and lactation. According to Indian standard, the total calorie intake for an Indian man has been fixed at 2,320 kilocalories if he leads a *sedentary* life. For those with moderate or heavy work, it should be 2,730 kilocalories and 3,490 kilocalories respectively. The corresponding figures for women are 1,900 kcal, 2,230 kcal and 2,850 kcal. The ideal man (or woman) should work for eight hours, sleep eight hours, spend 4 to 6 hours sitting or moving about and two hours in walking/active recreation or household duties. Energy needs of children and adolescents have been computed for reference children and adolescents; these reference

children were assumed to have a *moderate daily physical activity level*. Considering age, body weight, occupational activity, and non-occupational activity in a day the estimated energy requirement of has been shown **Tables 22.11A** and **22.11B**. The summary of recommended energy requirement for Indians is depicted in **Table 22.15A**.

Energy need in pregnancy should be adjusted for actual bodyweight, observed gestational weight gain and activity pattern of population.⁵ The average additional requirement of energy during pregnancy for an Indian woman of 55 kg body weight and considering pregnancy weight gain between 10 and 12 kg has been calculated as 350 kcal/day. Daily additional energy requirement of a woman doing exclusive breast feeding during the first 6 months would be 600 kcal and for partial breast feeding during 7 to 12 months, it would be approximately 520 kcal (**Table 22.15A**).

ENERGY EXPENDITURE OF PHYSICAL ACTIVITY

Whenever total energy intake exceeds the total energy expenditure there is positive energy balance leading to accumulation of fat. Physical activity is an important determinant of energy need of body. Physical inactivity (lack of physical activity) has been identified as one of the major risk factor for morbidity and mortality. It is desirable that individuals over the age of 20 years should undertake a minimum of 30 to 45 minutes of physical activity of moderate intensity (such as brisk walking 5-6 km/hr) to reduced risk of coronary heart disease, hypertension, diabetes mellitus, etc. Energy expenditure of some activities are given in **Table 22.12**.

TABLE 22.11A: Energy requirements of infants during the first year of life

Age in months	Daily energy requirement (kcal/kg/day)	
	Boys	Girls
0-1	115	105
1-2	105	100
2-3	95	95
3-4	80	85
4-5	80	80
5-6	80	80
6-7	80	80
7-8	80	80
8-9	80	80
9-10	80	80
10-11	80	80
11-12	80	80

Source: ICMR 2010 (Reference 5)

Energy requirement per day for a sedentary male worker weighing 60 kg (**Table 22.13**).

Assessment of the Energy Requirements of a Group or Family

Household diet survey provides information on food and nutrient intakes of that household for a given day, preferably for previous 24 hours. Raw equivalents of all the ingredients used for preparation of foods on the reference day are weighed and recorded. Also demographic particulars of the individuals who have participated in the meals are also recorded. The intake of various food stuffs are computed and expressed as average per CU/day, as follows:

TABLE 22.11B: Energy requirement of Indian men and women at different ages and body weights

Sex	Body weight kg	Age 18-30 yrs			Age 30-60 yrs			Age > 60 years	
		Sedentary work kcal	Moderate work kcal	Heavy work kcal	Sedentary work kcal	Moderate work kcal	Heavy work kcal	Sedentary work kcal	Moderate work kcal
Male	45	1986	2336	2985	2026	2383	3045	1590	1870
	50	2096	2466	3151	2078	2444	3123	1688	1985
	55	2208	2597	3319	2196	2579	3296	1786	2101
	60	2318	2727	3485	2275	2671	3420	1883	2216
	65	2430	2858	3652	2359	2736	3547	1981	2331
	70	2540	2988	3818	2442	2873	3671	2079	2446
	75	2716	3191	4078	2526	2971	3797	2177	2565
Female	40	1577	1856	2371	1714	2016	2576	1477	1737
	45	1685	1982	2532	1778	2092	2673	1553	1627
	50	1792	2108	2693	1841	2165	2767	1630	1917
	55	1899	2234	2854	1905	2241	2864	1706	2007
	60	2006	2360	3015	1966	2315	2958	1782	2097
	65	2113	2486	3176	2032	2390	3054	1860	2187
	70	2220	2612	3337	2095	2464	3149	1936	2277

Source: ICMR 2010⁵

TABLE 22.12: Energy expenditure on various physical activities (kcal/hr)*

Activity	Kcal/hr	Activity	Kcal/hr
Cleaning/Mopping	210	Shuttle	348
Gardening	300	Table Tennis	245
Watching TV	86	Tennis	392
Cycling		Volley Ball	180
15 (km/hr)	360	Dancing	372
Running		Fishing	222
12 (km/hr)	750	Shopping	204
10 (km/hr)	655	Typing	108
8 (km/hr)	522	Sleeping	57
6 (km/hr)	353	Standing	132
Walking 4 (km/hr)	160	Sitting	86

* Approx. energy expenditure for 60 kg reference man. Individuals with higher body weight will be spending more calories than those with lower body weight. Reference woman (50 kg) will be spending 5% less calories

$$\text{Average intake per CU/day (g)} = \frac{\text{Total raw amount used (g)}}{\text{Total CU of household (consuming the food)}}$$

Consumption Units (CU) of Individuals

The energy requirement of an adult reference man is taken as 'one consumption unit (CU)' and calorie coefficient for others are proportionately worked out on the basis of age, sex, physiological status and activity as indicated below.

The recommended coefficients for calculating energy needs of different members of the family are given in **Table 22.14**.

The above scale of coefficients is somewhat arbitrary and concerns only calories. It is not meant to be applied in assessing the needs for other nutrients.

The recommended intakes of various nutrients are shown in (**Tables 22.15A and 22.15B**). Additional allowances recommended for pregnant and nursing mothers are also given in the table.

TABLE 22.14: Consumption units according to age, gender, physiological status and activity

Age group and sex	Consumption Units (CU)	Age group, gender and physical activity	Consumption Units (CU)
1–3 years (B + G)	0.5	≥ 18 years Female – Non Pregnant Non Lactating	
4–6 years (B + G)	0.7	Sedentary	0.8
7–9 years (B + G)	0.9	Moderate	0.9
10–12 years (Boys)	1.0	Heavy	1.3
10–12 years (Girls)	0.9	≥ 18 years Female - Pregnant	
13–15 years (Boys)	1.1	Sedentary	0.9
13–15 years (Girls)	1.0	Moderate	1.0
16–17 years (Boys)	1.2	Heavy	1.4
16–17 years (Girls)	0.9	≥ 18 years Female - Lactating	
≥ 18 years Male		Sedentary	1.0
Sedentary	1.0	Moderate	1.1
Moderate	1.2	Heavy	1.5
Heavy	1.6		

TABLE 22.13: Energy requirement per day for a sedentary male worker

Basal metabolism	1440 for 24 hr (including 8 hr of sleep and rest)
8 hours light routine	320
8 hours occupational activity	400
Specific dynamic action	150
Total	2310 kcal

Assessment of Nutritional Status

Nutritional assessment can be done by two broad types of methods—direct and indirect given in **Table 22.16**.

Inadequacies in nutritional intake affect functional capacity and result in many adverse health outcomes with distinct expressions of malnutrition. Children adapt to inadequate diets through reduced physical activity and slowed rates of growth. The sign of wasting and some biochemical abnormalities (e.g. reduction in serum albumin) starts appearing at moderate degrees of malnutrition. At advanced stages of malnutrition, linear growth ceases, physical activity is severely curtailed, body wasting is marked, and clinical signs (e.g. edema, hair and skin changes) are noticeable.

It is important to identify the nutritional status at individual and community level to suggest appropriate corrective measures. Nutritional assessment requires value judgment regarding quality and quantity of intake and utilization of nutrients. This needs interpretation of information obtained from anthropometric, dietary, biochemical and clinical studies. Following are the methods of nutritional assessments.

CLINICAL EXAMINATION

One of simplest and practical methods of assessing nutritional status of individuals and at community level is clinical examination. Essentially the method is based

TABLE 22.15A: Recommended dietary allowances for Indians (Macronutrients and Minerals)

Group	Particulars	Body wt. kg	Net Energy kcal/d ^a	Protein g/d	Visible Fat g/d	Calcium mg/d	Iron mg/d
Man	Sedentary work	60	2320	60	25	600	17
	Moderate work		2730		30		
	Heavy work		3490		40		
Woman	Sedentary work	55	1900	82.2		20	35
	Moderate work		2230			25	
	Heavy work		2850			30	
	Pregnant woman		+350			30	
	Lactation						
	0-6 months		+600			77.9	
6-12 months	+520	70.2	30				
Infants	0-6 months	5.4	92 kcal/kg/d	1.16 g/kg/d	-	-	-
	6-12 months	8.4	80 kcal/kg/d	1.69 g/kg/d	-	500	46 µg/kg/d
Children	1-3 years	12.9	1060	16.7	27	600	09
	4-6 years	18	1350	20.1	25		13
	7-9 years	25.1	1690	29.5	30		16
Boys	10-12 years	34.3	2190	39.9	35	800	21
Girls	10-12 years	35.0	2010	40.4	35	800	27
Boys	13-15 years	47.6	2750	54.3	45	800	32
Girls	13-15 years	46.6	2330	51.9	40	800	27
Boys	16-17 years	55.4	3020	61.5	50	800	28
Girls	16-17 years	52.1	2440	55.5	35	800	26

^a Rounded off to the nearest 10 kcal/d

TABLE 22.15B: Recommended dietary allowances for Indians (Vitamins)

Group	Particulars	Vit. A µg/d		Thiamin mg/d	Riboflavin mg/d	Niacin equivalent mg/d	Pyridoxin mg/d	Ascorbic acid mg/d	Folate µg/d	Vitamin B ₁₂ µg/d	Magnesium mg/d	Zinc mg/d
		Reti-nol	β caro-tene									
Man	Sedentary work			1.2	1.4	16						
	Moderate work	600	4800	1.4	1.6	18	2.0	40	200	1	340	12
	Heavy work			1.7	2.1	21						
Woman	Sedentary work			1	1.1	12						
	Moderate work	600	4800	1.1	1.3	14	2.0	40	200	1		10
	Heavy work			1.4	1.7	16					310	
	Pregnant woman	800	6400	+0.2	+0.3	+2	2.5	60	500	1.2		
	Lactation			+0.3	+0.4	+4	2.5					12
	0-6 months	950	7600					80	300	1.5		
6-12 months			+0.2	+0.3	+3	2.5						
Infants	0-6 months	-	-	0.2	0.3	710 µg/kg	0.1	25	25	0.2	30	-
	6-12 months	350	2800	0.3	0.4	650 µg/kg	0.4				45	-
Children	1-3 years			0.5	0.6	8	0.9		80		50	5
	4-6 years	400	3200	0.7	0.8	11	0.9	40	100		70	7
	7-9 years	600	4800	0.8	1.0	13	1.6		120		100	8

Contd...

Contd...

Group	Particulars	Vit. A $\mu\text{g/d}$		Thiamin mg/d	Riboflavin mg/d	Niacin equivalent mg/d	Pyridoxin mg/d	Ascorbic acid mg/d	Folate $\mu\text{g/d}$	Vitamin B ₁₂ $\mu\text{g/d}$	Magnesium mg/d	Zinc mg/d
		Reti- nol	β caro- tene									
Boys	10-12 years			1.1	1.3	15	1.6	40	140		120	9
Girls	10-12 years			1.0	1.2	13	1.6				160	9
Boys	13-15 years	600	4800	1.4	1.6	16	2.0	40	150	0.2	165	11
Girls	13-15 years			1.2	1.4	14	2.0			to 1.0	210	11
Boys	16-17 years			1.5	1.8	17	2.0				195	12
Girls	16-17 years			1.0	1.2	14	2.0	40	200		235	12

Source: ICMR, National Institute of Nutrition, Hyderabad, 2010.

TABLE 22.16: Methods of nutritional assessment

Direct	Indirect
<ul style="list-style-type: none"> Clinical examination Anthropometry Biochemical tests Biophysical methods 	<ul style="list-style-type: none"> Morbidity data Mortality data Food consumption data (diet survey) Food production data

on examination of changes that can be observed or felt in different parts of body. Occasionally this can be supplemented in the field by certain physical tests with or without instrumental aids, such as testing of ankle jerks. Though the method is relatively inexpensive, the method requires careful training and continuous supervision by experts. Like any other method of assessment, the method has its own limitations, which must be known for its proper application. Major limitations include, lack of quantification of malnutrition and lack of specificity of clinical signs. Most signs of malnutrition are not specific to lack of a particular nutrient and often it can be associated with various non-nutritional factors. For example, bitot spots classically considered as pathognomonic of vitamin A deficiency, can be due to chronic conjunctival trauma from smoke, dust, eye infection, etc. Glossitis can be seen in niacin, folic acid, Vitamin B₁₂, or riboflavin deficiency. Clinical picture of angular stomatitis, often incorrectly considered as pathognomonic of ariboflavinosis, can result from excessive chewing of beetle nut chewing in India. However, judicious and proper application of the methods provides a nutritional status of the community. Following is the list of selected signs and symptoms commonly used for nutritional survey.¹⁹

Part involved	Signs
Hair	Lack of luster Thinness and sparse Dyspigmentation Flag sign Easy pluckability
Face	Diffuse depigmentation Nasolabial dyssebacia Moon faces
Eye	Pale conjunctiva Bitot spot Conjunctival/corneal xerosis Keratomalacia
Lips	Angular stomatitis/scar Cheilosis
Tongue	Palor, edema, Magenta tongue, Atrophic papillae
Teeth	Mottled enamels
Gums	Spongy bleeding gums
Glands	Thyroid enlargement
Skins	Xerosis Follicular hyperkeratosis Pellagrous dermatosis Flaky paint dermatosis
Nails	Koilonychia
Subcutaneous tissue	Edema
Muscular and skeletal system	Muscle wasting Epiphyseal enlargement Beading of ribs Knocked knee and bow legs
Gastrointestinal, Nervous and Cardiovascular system	Hepatomegaly Psychometer changes Mental confusion Sensory loss and motor weakness Loss of ankle and knee jerks Calf tenderness Cardiac enlargement

Source: WHO Expert Committee on Medical Assessment of Nutritional Status (1963).

NUTRITIONAL ANTHROPOMETRY

Anthropometry is the most frequently used method to assess the nutritional status of individuals or population groups. Measurements of nutritional anthropometry are based on growth in children and body weight changes in adults. Nutritional anthropometry has been defined as “measurements of the variations of the physical dimensions and the gross composition of the human body at different age levels and degrees of nutrition” (Jelliffe, 1966). Anthropometric measurements are sensitive over the full spectrum of malnutrition as compared to biochemical and clinical indicators, which are useful only at the extremes of malnutrition. In addition, anthropometric measurements are non-invasive, inexpensive and relatively easy to obtain. The main disadvantage of anthropometry is its lack of specificity, as it may be affected by several other factors, including intake of essential nutrients, infection, altitude, stress and genetic background.

Anthropometric indices (height, weight and BMI) are widely used for the assessment of the adequacy of energy intake. Body weights and heights of children reflect their nutritional and growth status; weights and heights of adults represent the cumulative effect of dietary intake over a long period. Continued overconsumption of energy especially in stunted individuals could lead to over-nutrition, obesity and increased risk of noncommunicable diseases.

Commonly used anthropometric measurements are:

1. Weight
2. Height
3. Mid-arm circumference
4. Head, chest, waist and hip circumference
5. Skin-fold thickness

Weight

Body weight is the most common and simplest anthropometric measure used for assessment of nutritional status. Body weight is an indicator of ‘current’ nutritional status of the individual, as weight fluctuates with nutrition. Unlike height which is irreversible, it reflects the current nutrition state. It is therefore a useful indicator for acute malnutrition.

Measurement of weight: The ideal weighing instrument is the lever actuated balance or a beam balance. However, in field situation a suitable instrument for weighing a child is a 25 kg hanging spring scale marked out in steps of 0.1 kg. After weighing pants are attached to the lower hook of the scale, the instrument is adjusted to zero. The child should be weigh in minimum clothing after putting on the weighing pants.

Weight for age indicator: Weight for age compares the weight of a given individuals with that of an individual of same age in the reference population. To know the

nutritional status of the child we can use weight for age reference table or growth chart.

Height

Height is a key variable in the calculation of relative body weight and frequently used as an indicator of the nutritional status. The presence of undernutrition in children is assessed using these three anthropometric parameters (*weight-for-age*, *height-for-age* and *weight-for-height*) and by comparing them with internationally accepted reference standards. Appropriate height-for-age of a child reflects linear growth and can measure long-term growth faltering or **stunting**, while appropriate weight-for-height reflects proper body proportion or the harmony of growth. Weight-for-height is particularly sensitive to acute growth disturbances and is useful to detect the presence of **wasting**. Weight-for-age represents a combined effect of both the criteria, i.e. height-for-age and weight-for-height. Thus, patients classified on the basis of weight-for-age criteria are a mixed group in terms of both linear growth and body proportion and thus can be used for the diagnosis of underweight children.

If a child has a low height-for-age, i.e. a Z-score below two standard deviations of the reference population mean (-2 Z-score), such a child is categorized as “stunted”. Similarly, a low weight-for-age is diagnostic of an “underweight” child, while a low weight-for-height is indicative of “wasting”. WHO and UNICEF jointly recommended a cut-off of -3 Z-scores for definition of severe acute malnutrition (SAM) based on weight-for-height criteria (**Table 22.17**)

When assessing weight-for-height, infants and children under 24 months of age should have their lengths measured lying down (supine). Children over 24 months of age should have their heights measured while standing. For simplicity, however, infants and children under 87 cm can be measured lying down (or supine) and those above 87 cm standing. An infantometer is use to measure the recumbent ‘length’. In adults and older children, the height is measured using a vertical measuring rod, the ‘Anthropometric rod’.

Mid Upper Arm Circumference (MUAC)

The mid-upper arm circumference is the circumference of the upper arm at that same midpoint, measured with a non-stretchable tape. It is based on the observation

TABLE 22.17: Recommended diagnostic criteria for SAM in children aged 6–60 months²¹

Indicator	Measure	Cut-off
Severe wasting ²	Weight-for-height ¹	< -3 SD
Severe wasting ²	MUAC	< 115 mm
Bilateral edema ³	Clinical sign	

¹Based on WHO Standards (www.who.int/childgrowth/standards)

^{2,3}Independent indicators of SAM that require urgent action

that this measurement does not change much in children between six months and five years old, so comparison to a “normal” measurement is useful. The mid-upper arm circumference is measured on the non-dominant arm (left arm in case of right handed subjects and vice versa) of the subject. The midpoint between the tip of the acromion of scapula and olecranon process of ulna is located with the arm flexed at the elbow.

Shakir introduced a simple tri-colored tape in 1975, called as the Shakir’s tape. This can be used by field worker even with minimum skill. The MUAC less than 12.5 cm cutoff value fall in red zone of the tape indicate marked danger, that between 12.5 and 14 cm fall in yellow zone indicate marked caution and more than 14.0 cm fall in green indicate normal. However, WHO and UNICEF in 2009 jointly recommended a lower cutoff value of MUAC (<115 mm) for identification severe wasting. The MUAC less than 115 mm in the children aged 6 to 59 months gives an indication of the degree of wasting and is a good predictor of mortality.

Waist and Hip Circumference

Waist and hip circumference is measured in adult to detect abdominal obesity. Waist circumference is measured with a fiber reinforced plastic tape at point mid way between the lowest margin of the ribs and the iliac crest. Adult men with waist circumference ≥ 102 cm and adult women with ≥ 88 cm were considered as having abdominal obesity.¹⁹ Hip circumference are measured with the tape a point of maximum protuberance of buttocks. Adult men with waist hip ratio of ≥ 0.95 and women with ≥ 0.80 were considered as having abdominal obesity.

BODY MASS INDEX (BMI)

The BMI is the most widely used anthropometric index for the assessment of the nutritional status in adults as it reflects the effect of both acute and chronic energy deficiency/excess. BMI, however, does not clearly bring out the entire extent of chronic undernutrition. For instance those who are stunted and have low body weight may have normal BMI. Continued over-consumption of energy especially in stunted individuals could lead to over-nutrition, obesity and increased risk of non-communicable diseases. Thinness (low BMI) is also an indicator of risk to health, often being associated with general illness and other undernutrition related consequences like osteoporosis and fractures in the elderly. BMI is calculated from height and weight measurements (weight in kg/ height in meters²). A detail is given in obesity chapter.

BIOCHEMICAL TESTS

Biochemical indicators require laboratory facilities, costly equipment, and highly qualified staff to perform and

interpret tests as well as equipment, facilities, and protocols for specimen collection, specimen storage, specimen transit, and the reporting of results.

BIOPHYSICAL METHODS

These tests are not used widely for community surveys because of several reasons. Examples are: radiological examination (for diagnosis of rickets, osteomalacia, fluorosis) and dark adaptation test (for diagnosis of vitamin A deficiency).

MORBIDITY DATA

The diagnosis of marasmus or kwashiorkor, when made properly, can, of course, be a reliable index of nutritional status of the community. In view of the close association between diarrhea and malnutrition, the occurrence of diarrhea may give some rough indication of nutritional status. The same holds true of measles to some extent. In case of disease like beriberi, rickets, anemia and night blindness, the significance in relation to the specific nutrient deficiency is obvious.²³

MORTALITY DATA

Infant mortality rate is associated with malnutrition in the community. Such association is mainly related to the postneonatal mortality component of the IMR. However, an even better indicator of malnutrition is the 1 to 4 years (12 to 60 months) mortality. This may be expressed in the following three ways:¹⁹

1. Percentage of deaths below 60 months to total deaths.
2. Age-specific mortality rate (Annual 1 to 4 years death rate per 1000 children aged 1 to 4 years).
3. Ratio of 1 to 4 year mortality rate to 1 to 12 months mortality rate (Wills and Water low index).

NUTRITIONAL INTAKE ASSESSMENT

Measures of nutritional intake estimate the amount of food a person is eating and can be used to assess adequacy of dietary nutrients intake (**Table 22.18**). These methods are called diet survey. Dietary survey methods measure actual food intake at the individual or family level by asking respondents to recall what they ate in the previous 24 hours and analyzing the chemical and nutrient content of diets. This information is then compared with RDA to determine the deficiency of nutrient intake.

This is collected by conducting a diet survey in a representative sample of the population. It can be done in the following six ways:

1. *Random diet interview*: Here the person is asked to state what and how much he or she generally eats or drinks at different times such as breakfast, lunch, dinner, evening snacks, etc. The total amount

- of various nutrients consumed during 24 hours is then calculated with the help of standard food tables.
- Recall method:** Here the subject is asked to state what he has eaten during the last 24 hours, starting from the time of interview backwards. The usual 24 hours recall method may also be extended to 48 or 72 hours recall.
 - Diet record:** Literate subjects can be asked to record their actual dietary intake on plain paper or printed forms supplied beforehand. This method can be extended over 1,3,7 days or even more. However, it can be practical only in well-defined situations.
 - Sample or aliquot method:** The person is asked to keep a duplicate sample of everything consumed in bags specially provided for this purpose. The amount collected is weighed, mixed, homogenized in a mixer and then chemically analyzed. This is obviously an experimental method used only for clinical research.
 - Direct measurement method:** This is again an experimental method applicable only in a metabolic or research ward. Each and every item of food is weighed accurately to the nearest gramme. The 24 hour food consumption is calculated by deducting the food left over from the total food served.
 - Domestic food balance method:** All the foodstuffs present in the house on a particular day are listed and measured. The same is done in case of any foods purchased or otherwise entering the house over a period of a 1 week. The food remaining at the end of 1 week is again measured. The total daily consumption divided by the number of reference dietary units (as described earlier) gives the actual 24 hours dietary intake. Due allowance is made for any foods eaten outside the house.

FOOD PRODUCTION DATA

This can be applied at the national level where total food consumed (food grown plus food imported minus food exported or wasted) is divided by the total population in terms of reference dietary units. Average national consumption per reference consumption unit can be obtained in this manner.

Nutritional Deficiency States

EPIDEMIOLOGICAL ASPECTS

The importance of optimal nutrition for health and human development is well recognized. Currently the country is in the midst of rapid socioeconomic, demographic, nutrition and health transition. While the country is yet to overcome poverty, undernutrition and communicable diseases, it is increasingly facing problems related to affluence. Because of poor economic condition mal distribution of food, lack of nutrition

awareness and unhygienic environment, India and other developing countries faces major burden of nutrition related disorders. Long-term undernutrition leads to stunting and wasting, non-communicable chronic diet related disorders, increased morbidity and mortality and reduced physical work output leading to economic loss to the country. On the other hand with increasing urbanization, consumption of higher amount of fat, sugar and refined food with less dietary fiber coupled with sedentary lifestyle contributing to higher prevalence of obesity, heart disease, hypertension particularly among affluent population.

COMMON NUTRITION PROBLEMS IN INDIA

The major nutrition problems of India can be classified as follows:

- Undernutrition
 - Protein Energy Malnutrition (Marasmus and Kwashiorkor)
 - Iron deficiency
 - Iodine deficiency
 - Vitamin "A" deficiency.
 - Low Birth Weight Children
- Over-nutrition: Following are epidemiological determinants of malnutrition.

AGENT FACTORS

- Energy deficiency:** This is the most common cause of undernutrition leading to the so-called energy protein malnutrition. It is usually associated with deficiency of other nutrients as well.
- Other nutrient deficiencies:** When one or more than one nutrients are inadequate in the food, specific conditions may occur such as night blindness, beriberi, pellagra, anemia, rickets, etc.

HOST OR HUMAN FACTORS

- Age and sex:** Basal metabolic rate (BMR) and physical expenditure of energy vary with age and sex. Kwashiorkor is found in young children. Osteo-

TABLE 22.18: Average intake of nutrients and their adequacy

Nutrient	Daily intake per consumption unit*	RDA**	Intake as % of RDA
Energy (kcal)	1994	2425	82
Protein (g)	65.5	60	100
Calcium (mg)	368	400	92
Iron (mg)	30	28	108
Vitamin A (mg) (Retinol)	470	600	78
Thiamine (mg)	1.7	1.2	141
Riboflavin (mg)	0.9	1.4	65
Nicotinic acid (mg)	15.2	16	145
Vitamin C (mg)	42.6	40	107
Fat (g)	10	20	50

Based upon data of *National Nutrition Monitoring Bureau⁴ and **ICMR⁵

malacia and nutritional anemia occur in pregnant women and nursing mothers.

- *Habits, customs and food fads:* These often contribute to malnutrition. Examples are the habit of throwing away excess water after cooking of rice, the custom of discarding colostrum, the customary prestige attached to desi ghee and the modern trend of increased intake of processed and packaged costly fast foods, often containing harmful preservatives.
- *Physiological and pathological stress:* Undernutrition may be secondary to interference with digestion, absorption and utilization of food, increase in nutritional requirements or increased nutrient loss. Digestion is affected in gastric, duodenal, biliary and pancreatic disease. Absorption is affected in disease of the jejunum and ileum, such as idiopathic tropical reabsorption syndrome (ITMS) or tropical sprue. Prolonged use of mineral oil may interfere with absorption of fat-soluble vitamins. Nutritional needs are increased in exercise, pregnancy and hyperthyroidism. In fever, one degree Celsius rise in temperature raises the BMR by 13%. Leukemia and other malignant diseases also increase the BMR. Examples of increased excretion of loss are glycosuria in diabetes, protein loss in burns, exudates and transudates, salt loss in excessive perspiration and diarrhea and iron loss in hookworm infection.
- *Psychological state:* A person tends to eat more in pleasant company and less when the mood and surroundings are gloomy.

Psychogenic factors are known to play an important role in anorexia nervosa.
- *Heredity and constitution:* Some nutrition related diseases are, at least in part, genetically determined. Examples are obesity, diabetes and celiac disease.

ENVIRONMENTAL FACTORS

These may be related to physical, socioeconomic or biological environment.

- *Physical factors:* Geographic location, climate, soil, agricultural development and population density play important role in determining nutritional status. For example, rickets occurs in those areas where there is less exposure to sun. Beriberi is found mainly among the rice eating people of Asia. Pellagra is found in those parts where the staple food is maize or jawar. Hypovitaminosis A and scurvy occur in those months of the year when fresh vegetables are not available. Pellagra, again is at peak in early summer when more maize is eaten. Goiter is endemic in the foothills of Himalayas.
- *Socioeconomic factors:* A large part of the world's population obtains food by purchase or barter. People

with less purchasing power suffer more from under-nutrition, especially during the natural calamities such as crop failure and war. Religious and social customs and taboos are other factors which affect food intake and nutritional status. The role of socioeconomic and political factors in malnutrition is classically brought out by the example of Orissa. The only districts in India where starvation deaths occur are Koraput and Kalahandi in this state. This is in spite of the fact that these districts are the granaries of Orissa. The production of pulses in these two districts is so much that not only the demands of the whole state are met but also there is surplus to be exported to nearby states. These two districts also produce the highest quantum and best type of cotton in Orissa. However, the largely tribal population in these districts is exploited by a few royal families that own 80% of the land.²⁴

- *Biological factors:* Coexisting communicable and parasitic diseases such as hookworm, roundworm,^{25,26} *Giardia*^{27,28} and malaria debilitate people and produce nutritional deficiency. In addition, significant crop and food destruction is caused by insects and rodents, especially in the tropics.

Protein Energy Malnutrition (PEM)

The term PEM is really a misnomer because protein deficiency is very uncommon. Almost all diet surveys carried out in different parts of the world have shown that the proportion of protein in the diet of most people, whether rich or poor, vegetarian or nonvegetarian, children or adults, is adequate.

The primary cause of PEM is chronic energy deficiency. Undernutrition starts as early as conception. Both clinical and sub-clinical undernutritions are widely prevalent even during early childhood and adolescence. Though the prevalence of florid forms of severe PEM like *kwashiorkor* and *marasmus* among preschool children is <1%, countrywide surveys indicate that about 43% of <5 year children suffer from sub-clinical undernutrition such as underweight (weight for age <median – 2SD of WHO child growth standards). The studies have shown that there is a steep increase in the prevalence of underweight among young children, from 6 months of age to 24 months of age. This is attributable to faulty infant and young child feeding practices prevailing in the community. Persistent undernutrition throughout the growing phase of childhood leads to *short stature* in adults.

Malnutrition impairs immune function, and malnourished children are prone to frequent infections that are more severe and longer-lasting than those in well-nourished children thus perpetuating into a malnutrition–infection–malnutrition cycle. The spectrum of PEM includes mild, moderate and severe form.

CLASSIFICATION OF PEM

PEM is usually assessed on the basis of anthropometric criteria. The three measurements commonly used are weight, height and midarm circumference, out of which weight recording is by far the most common.

Mild protein-energy malnutrition: Weight loss in children or adults, or lack of weight gain in children leading to an observed weight that is 1 or more but less than 2 standard deviations below the mean value for the reference population (or a similar loss expressed through other statistical approaches).

Moderate protein-energy malnutrition: Weight loss in children or adults, or lack of weight gain in children leading to an observed weight that is 2 or more but less than 3 standard deviations below the mean value for the reference population (or a similar loss expressed through other statistical approaches).

SEVERE MALNUTRITION

The World Health Organization (WHO) defines severe acute malnutrition as a mid-upper arm circumference (MUAC) < 11.5 cm, a weight-for-height z-score (WHZ) below -3, or the presence of bilateral pedal edema in children with kwashiorkor.²¹ In the absence of anthropometric assessment, severe acute malnutrition can also be diagnosed by assessing children for visible severe wasting, defined as the presence of muscle wasting in the gluteal region, loss of subcutaneous fat, or prominence of bony structures, particularly over the thorax. Severe acute malnutrition differs from chronic malnutrition, which manifests as stunting. Complicated severe **acute malnutrition** is a life-threatening condition requiring urgent, specialized treatment.

CLINICAL FEATURES

Severe malnutrition can take two extreme forms, viz, marasmus and kwashiorkor. Out of these, marasmus is by far the more common and less serious, the maximum mortality being found when both are present. Together, i.e. marasmic kwashiorkor. A simple method of categorizing these conditions is given in **Table 22.19**.

The characteristic features of marasmus are marked loss of weight, wasting of muscles and loss of subcutaneous fat. As a result, the child appears to be just

skin and bones with wrinkled face and shining alert eyes, giving the appearance of a “wise, old man”. Kwashiorkor is mainly a disease of toddlers (age group 1 to 3 years) but may be found upto five years of age. The characteristic feature is edema, giving rise to “moonface”, usually accompanied by skin lesions (peeling skin), irritability and lack of interest in surroundings. Loss of weight may not be apparent because of edema. Kwashiorkor is much less common than marasmus. However, it is more serious and may be fatal within days to weeks, if untreated. Marasmic kwashiorkor is a mixed syndrome characterised by body weight less than 60% in the presence of edema. It is more serious than simple kwashiorkor.

Iron Deficiency

The term ‘nutritional anemia’ encompasses all pathological state in which the hemoglobin concentration fall below a critical level, due to deficiency of one or more nutrients. Iron deficiency and anemia caused by it steal vitality from the young and old, threaten the health of pregnant women, impair the cognitive development of children and in their most severe forms can be a direct cause of death.³²

Nutritional anemia occurs frequently in both developing and industrialized countries.³³ Worldwide, at any given moment, more individuals have iron deficiency anemia than any other health problem.³⁴ The estimated prevalence in South East Asia is 50 to 70%.³⁵ Prevalence rates are usually considerably higher in pregnant women, with an overall mean of 51%.³⁴ Unlike reported figures for protein energy malnutrition and vitamin A deficiency, which are declining, estimates suggest that anemia prevalence rates are increasing.³⁵ Iron supplementation programs have been carried out in many places throughout the world over the last two decades. Still, the prevalence of iron deficiency anemia does not appear to be declining.³⁵

Anemia is a major health problem in India, especially among women and children. Anemia can result in maternal mortality, weakness, diminished physical and mental capacity, increased morbidity from infectious diseases, perinatal mortality, premature delivery, low birth weight, and (in children) impaired cognitive performance, motor development, and scholastic achievement. Among children between the ages of 6 and 59 months, the great majority (70%) are anemic. More than half of women in India (56%) have anemia, including 39 percent with mild anemia, 15 percent with moderate anemia, and 2 percent with severe anemia.³⁶ In India, the prevalence of anemia is high because of low dietary intake, poor bio-availability of iron in phytate fiber-rich Indian diet and high incidence of infection such as malaria, hookworm infestations, etc.

TABLE 22.19: Classification of severe PEM*²¹

% weight for age	Edema	
	Present	Absent
80 to 60	Kwashiorkor	Undernourished
Below 60	Marasmic Kwashiorkor	Marasmus

*Using 60th percentile of Harvard values as the reference.

It may be mentioned that, for practical purpose, nutritional anemia may be regarded as iron deficiency anemia because this is the most common cause of the former, the two other being folic acid deficiency and B₁₂ deficiency, both of which are much less common. It may also be mentioned that anemia is only a late manifestation of iron deficiency. In mild and early stages of iron deficiency, adverse physiological alterations and symptoms may be seen in the absence of anemia. At a matter of fact, severity of symptoms in iron deficiency is not closely correlated with the degree of anemia and the response to iron therapy often precedes the rise in blood hemoglobin.³⁷ This is so because symptoms in iron deficient individuals are attributable not only to low blood hemoglobin but also to alterations in tissue metabolism.

Iron deficiency can occur either because of excessive body loss or because of inadequate intake. The former is much more common.³⁷ Gastrointestinal and female genital tract are the two most common sources of blood loss. Hookworm infection is an important preventable cause of blood loss. Dietary iron intake is usually adequate. Iron intake in Indian diet has, in fact, been estimated to be 108%. The real cause of the widespread iron deficiency anemia in developing countries is probably attributable to two factors—decreased absorption of iron and increased loss due to intestinal parasites.

IRON DEFICIENCY ANEMIA

Iron deficiency is defined as a condition in which there are no mobilizable iron stores and in which signs of a compromised supply of iron to tissues, including the erythron, are noted. The more severe stages of iron deficiency are associated with anemia. When iron-deficient state occurs, hemoglobin concentrations are reduced to below-optimal levels. When individual hemoglobin levels are below two standard deviations ($-2SD$) of the distribution mean for hemoglobin in an otherwise normal population of the same gender and age who are living at the same altitude, iron deficiency anemia is considered to be present (**Table 22.20**).³⁸

Severe anemia in pregnancy is defined as hemoglobin <7 g/dl and requires medical treatment. Very severe anemia is defined as hemoglobin <4 g/dl. Very severe anemia in pregnant women is a medical

emergency due to the risk of congestive heart failure; maternal death rates are greatly increased.

PREVENTION STRATEGIES

Prevention strategies must be sustainable involving a wide range of sectors and organizations.

Dietary Improvement

- The approaches are designed to increase micronutrient intake through the diet.
- Bioavailability of iron in usual diets can be improved by altering meal patterns to favor enhancers, lower inhibitors, or both. **Enhancers** of iron absorption includes heme iron in meat, poultry, fish, and seafood, vitamin C; some fermented or germinated food and condiments, such as sauerkraut and soy sauce. **Inhibitors** of iron absorption are phytates, present in cereal bran, cereal grains, nuts, and seeds, etc. food with high inositol content; iron-binding phenolic compounds (tannins); foods that contain the most potent inhibitors such as tea, coffee, cocoa, herbal infusions, certain spices, etc. calcium, particularly from milk and milk products.

Food Fortification

There is a consensus that enrichment (or fortification) of food is an effective long-term approach to improving the iron status of populations. Legislative action to ensure the quality and safety of iron-fortified foods, and honest and fair practices in marketing them, may also be needed. Several iron fortificants have been used successfully in a variety of national programmes. Where bread and pasta are abundantly consumed, and flour is milled in only a few places, several iron fortificants have been added successfully during the milling process.

Fortified Foods for Young Children

Normal-birth-weight infants who are exclusively breastfed do not need iron supplements for the first 4 to 6 months of life. When complementary feeding begins, and certainly after 6 months of age, infants need an additional source of iron to maintain adequate

TABLE 22.20: Hemoglobin levels defining anemia³⁸

Age and sex group	Hemoglobin level (g/dl)				
	Non anemic	Anemic	Mild anemia	Moderate anemia	Severe anemia
Children 6–59 months	11.0 or more	<11.0	10–10.99	7–9.99	<7
Children 5–11 years	11.5 or more	<11.5	10–11.49	7–9.99	<7
Children 12–14 years	12.0 or more	<12.0	10–11.99	7–9.99	<7
Non-pregnant women	12.0 or more	<12.0	10–11.99	7–9.99	<7
Pregnant women	11.0 or more	<11.0	10–10.99	7–9.99	<7
Men	13.0 or more	<13.0	10–12.99	7–9.99	<7

Source: WHO³⁸

iron nutrition and prevent iron deficiency anemia. Since cereals are widely used as early complementary foods, they should be fortified during their commercial preparation.

Iron Supplementation

Iron supplementation is the most common strategy currently used to control iron deficiency in developing countries. Supplementation is most often used to treat existing iron deficiency anemia. It is also considered as a preventive public health measure to control iron deficiency in populations at high risk of iron deficiency and anemia. Therapeutic supplementation should be part of the health care delivery system. In India under National Nutritional Anemia Control pregnant women are recommended to have 100 mg elemental iron per day for 100 days after the first trimester of pregnancy; a similar dose applies to lactating women and IUD acceptors.

Control of Infection

Parasitic disease control programs, in particular those directed to hookworm, schistosomiasis and malaria control are effective in controlling iron deficiency anemia. Periodic de-worming by single dose Albendazole 400 mg three times in a year in endemic areas and twice a year in nonendemic areas is recommended.

Health and Nutrition Education

Policy decision: Incentive policies and improved farming systems that favor the development, availability, distribution, and use of foods that enhance iron absorption.

Link intervention strategies to related health and nutrition programs (e.g. family planning, breastfeeding promotion, complementary feeding, reproductive health, IMCI).

Others measures: Emergency food aid for refugees and displaced persons, agricultural, socio-economic improvement, nutritional education, etc.

Iron Absorption

The percentage of iron absorbed from diet can be increased by the following means:

- **Increasing ascorbic acid intake:** Vitamin C is known to increase iron absorption. It is, hence, advisable to promote the use of lemon and fresh fruits and vegetables, especially leafy vegetables.
- **Decreasing phytate content of food:** Phytic acid in the cereals binds iron as iron phytate. The leavening of flour by yeast breaks down phytates by the action of the enzyme phytase, thus making more iron available for absorption.

- **Incorporating heme iron in diet:** Iron absorption mechanisms are different for heme iron and nonheme iron, a higher proportion of the former being absorbed. It has been found that a small amount of flesh foods, when consumed with vegetarian food, increases the percentage of iron absorbed from the diet. The exact mechanism of this is not known, but an as yet unidentified iron absorption promoting factor in animal foods has been postulated. However, such effect is not seen in response to egg.

Besides attempting to increase the degree of iron absorption, another approach toward improving iron nutritional status is increasing the intake of iron. High iron content in diet ensures that more iron is ultimately absorbed. Iron content in diet can be increased by augmenting the intake of iron rich foods, particularly leafy vegetables, and by taking oral iron preparations. Costly iron preparations offer no special advantage and ferrous sulphate is still the best and cheapest. This is the preparation used in the National Nutritional Anemia Prophylaxis Program described later. An iron deficient patient absorbs as much as 20% of iron taken as ferrous sulphate.³⁷

Most vulnerable group to iron deficiency anemia: Anemia is prevalent in all ages and both sexes. But the most vulnerable groups are pregnant women, women of reproductive age group, adolescent girls and young children.

Consequences of iron deficiency anemia:

During pregnancy	Increases maternal mortality Increases incidence of abortion Increases number in LBW babies Increases infant mortality
Young children	Low IQ Small attention span High absenteeism due to morbidity Poor performance in school
Adolescent girls	Early marriage and pregnancy aggravate anaemia.
All age groups	More infection due to low immunity Exhaustion Headache Lethargy Low productivity due to decreased work capacity Breathlessness Palpitation

Vitamin A Deficiency

Vitamin A deficiency, usually denoted by the term xerophthalmia, is fairly common in India and many other countries. It is unfortunate that it should be so, because the means of preventing xerophthalmia are known and are fairly cheap. Adequate intake of green leafy vegetables ensure good vitamin A nutritional status. In spite of this, it is estimated that 13000 children become blind due to vitamin A deficiency every year in India alone. The figure is 16000 in Bangladesh.

TABLE 22.21: Classification of xerophthalmia^{39,40}

Code	Condition	Diagnostic	
		use	limits*(%)
X1A	Conjunctival xerosis	Nonspecific	
X1B	Bitot's spot with conjunctival xerosis	Useful in very young children	0.5
X2	Corneal xerosis	Useful	0.01
X3A	Corneal ulceration/keratomalacia (< 1/3 of corneal surface)	Useful	0.01
X3B	Corneal ulceration/keratomalacia (≥ 1/3 of corneal surface)	Useful	0.01
XN	Night blindness	Qualitative use	
XF	Xerophthalmia funds	Not employed	
XS	Corneal scare	Uncertain specificity	0.05

*Prevalence more than this in preschool children should cause public health concern.

Surveys in India have revealed widespread low dietary intake of vitamin A. According to the data of National Nutrition Monitoring Bureau, vitamin A intake in rural areas was adequate in none of the states surveyed. The highest daily intake was in Andhra Pradesh, about 415 to 450 mg. In all others, daily intake was less than half of the RDA. Clinical surveys for signs of xerophthalmia conducted by the NNMB have revealed a prevalence of 1.8 to 10.6% in preschool children in various states. These prevalence figures are based upon presence of one or more ocular signs of xerophthalmia, including corneal and conjunctival signs. The various signs are listed in **Table 22.21** which gives the classification of xerophthalmia recommended by the WHO.³⁹

Out of the signs listed in the above table, the most reliable sign that is reasonably specific and unlikely to be missed is Bitot's spot. There is reliable evidence that 2 to 3% children below 5 years age in India have Bitot's spots.⁴¹ In view of the high prevalence of xerophthalmia, a national xerophthalmia prophylaxis program has been launched in India as described later. It ought to be mentioned that it was claimed sometime ago⁴² that six monthly administration of vitamin A 200,000 units reduced child mortality by as much as 30%. Serious doubts have been expressed about this claim.^{43,44} A double blind study of 15,875 preschool children at National Institute of Nutrition found that mortality was unaltered in children who received vitamin A.

Iodine Deficiency

Human body and various important functional compounds in it are composed of several elements such as Carbon, oxygen, nitrogen, hydrogen iron, zinc, etc. Iodine is one such element which is a highly volatile element. It is a constituent of two important hormones, i.e. T3 (Triiodothyronine) and T4 (Thyroxine)

synthesized in thyroid gland. These hormones are essential for proper physical growth and mental or brain development from the fetal stage throughout life.

Due to low iodine intake with the food and subsequent low level of iodine in the thyroid gland, the gland tries to compensate by enlarging itself to make adequate amounts of T3 and T4. This enlargement of gland is goiter.

PREVALENCE

Goiter is prevalent in almost all submountainous regions in various countries, there being nearly 200 million cases in the world. Globally, 1570 million people are living in IDD endemic areas.^{44a} In India, the disease is endemic in the sub-Himalayan areas, extending over a distance of 2400 km from Kashmir to NEFA, including the northern districts of Punjab, UP, Bihar and West Bengal. Cases are also found in Satpuda and Sahyadri hills of Maharashtra. Recent surveys have revealed high prevalence in hitherto unsuspected areas, including Delhi and its neighboring regions. For example, a village 40 km from Delhi has been found to have goiter prevalence of 38.8% in the total population. 6.9% of the population had visible goiter (grade II and III). The prevalence was higher in females.^{44b} Studies in six districts of West Bengal have revealed goitre prevalence as low as 11.3% to as high as 25.9%.⁴⁵⁻⁴⁸ In India, about more than 71 million persons are suffering from goiter and other iodine deficiency disorders.⁴⁹ Earlier 321 districts in the country have been surveyed in 28 states and 7 Union Territories for IDD and 260 districts have been found to be endemic (i.e. prevalence of IDD is more than 10%).⁵⁰

AGENT FACTORS

Deficiency of iodine is the main factor. Other contributory factors are excess of rapeseed, mustard, yellow turnip, cabbage, maize, sweet potatoes and groundnut skin in the diet.

HOST FACTORS

Heredity plays negligible role. School going children, adolescent and pregnant women are more susceptible to goitre.

ENVIRONMENT FACTORS

The iodine content in soil and water is low in the hilly areas. Consequently, vegetables, etc. grown in these regions are poor in iodine.

CLINICAL FEATURES

Iodine Deficiency Disorders (IDD) – a term coined by Hetzel in 1983, encompasses the collective clinical and

subclinical manifestations of iodine deficiency.⁵¹ IDD impact refers to all of the ill-effects of iodine deficiency in a population, which can be prevented by ensuring that the population has an adequate intake of iodine.⁵² Iodine deficiency is claimed to be world's single most significant cause of preventable brain damage and mental retardation.

SPECTRUM OF IODINE DEFICIENCY DISORDERS⁵³

Pregnancy	Spontaneous Abortion Still births
Fetus	Abortions Still births Congenital anomalies Increased perinatal mortality Increased infant mortality
Congenital damage due to iodine deficiency	Neurological Cretinism Mental deficiency Deaf mutism Spastic diplegia Squint Myxedematous Cretinism Dwarfism Mental deficiency Psychomotor defects
Neonate	Neonatal goitre Neonatal hypothyroidism
Child and adolescent	Goiter Juvenile hypothyroidism Impaired mental function Subnormal intelligence (loss of 10 to 15 IQ points) Retarded physical development Delayed motor milestones Hearing and speech defects Stunting and muscle disorder
Adult	Goitre and its complications Hypothyroidism Lack of energy Impaired mental function Lowered productivity
Animal	Reproductive failure Decreased yield of milk, egg, etc.

Goiter in the neck may be palpated by clinical examination and the goiter is graded as follows:

Grade 0: Thyroid gland is neither palpable nor visible/ no goiter.

Grade 1: A mass in neck that is consistent with an enlarged thyroid that is palpable but not visible when the neck is in normal position. The mass moves upwards with deglutition/goiter palpable but not visible.

Grade 2: A swelling in the neck that is visible when the neck is in normal position and is consistent with enlarged thyroid when the neck is palpated/goiter visible and palpable.

Pregnant mothers transfer thyroid hormones minimally to fetus; however inorganic iodine obtained from food is transferred to fetus and fetus starts synthesizing thyroid hormones after first trimester. Irreversible brain damage of fetus and psychomotor development affected, when pregnant mothers do not get adequate supply of iodine. The Intelligence Quotient (IQ) score of children living in an iodine deficient environment is nearly 13 IQ points less than those living in iodine sufficient environments

MAIN CAUSES OF IODINE DEFICIENCY IN INDIA

Iodine Deficiency Disorders in India are mainly due to environmental factors.

Factors for environmental deficiency of iodine are deficiency of iodine in soil which is caused by washing of the top soil by rains, glaciers and snows from the mountainous regions down the rivers to the sea. Flood water also takes up iodine and multiple cropping practices on the same soil deplete soil iodine. Seafoods rich in iodine are much less available and costly. Goitrogen substances present in food reduce iodine absorption. Low iodine content in most foods together with dependence on single staples by a large percentage of population are some of the environmental factors for iodine deficiency.

Total quantity present in body is 15–20 mcg mostly in thyroid gland. Iodine needed in minute quantities daily is 150 mcg; it is just as much as is contained on a pin head. A tea spoonful of iodine is enough for the whole life time of a person.

Global Iodine Deficiency Disorders preventive day is being celebrated on 21st October, that emphasizes daily consumption of iodised salt.

National Nutrition Programs

In view of the high prevalence of malnutrition in India, the government has launched several nutrition programs at the national level. There have been recently reviewed.⁵⁴ During first and second Five-Year Plans, the thrust was on increased food production and some effort was made to provide supplementary feeding to vulnerable groups. In the third plan, the Applied Nutrition Program was started with the aim of fulfilling these objectives.

The Mid-day Meal Program and National Goitre Control Programs were initiated in 1962 to 1963, and extended to the entire country during subsequent years. During the fourth plan, National Nutritional Anemia Prophylaxis Program and National Program for Prophylaxis of Nutritional Blindness due to vitamin A deficiency were launched to combat morbidity due to nutritional anemia and vitamin A deficiency respectively.

The Special Nutritional Program (SNP) for preschool children and pregnant women and nursing mothers was introduced in 1970 to 71. It was originally launched as a central program and was transferred to the state sector in the fifth Five-Year Plan, as part of the Minimum Needs Program. The Integrated Child Development Services (ICDS) scheme was started in 1975 to 76. The following eight major nutrition programs are being implemented in India at present:

1. Integrated Child Development Services Scheme (ICDS) Supplementary Nutrition.
2. National Nutritional Anemia Prophylaxis Program
3. National Goitre Control Program.
4. National Program for Prevention of Nutritional Blindness due to vitamin A deficiency.
5. Mid-day Meal Program.
6. Special Nutrition Program.
7. Applied Nutrition Program.
8. Chief Minister's Noon Meal Program (Tamil Nadu).

Besides the above, several small nutrition programs are also being implemented. The international agencies like CARE, WFP, OXFAM and DANIDA are also supporting or organising supplementary nutrition program activities.

The aim of all the nutrition programs is to provide additional nutrients to target groups to fill the gap between intake and requirement. The supplementation of nutrients like vitamin A, iron, iodine, protein and calories are examples of the above strategy.

In general, the main beneficiaries of nutrition programs are the nutritionally vulnerable preschoolers, school children, pregnant women and lactating mothers, constituting about 40% of the total population.

Integrated Child Development Services (ICDS)

The ICDS program has been described in detail in Chapter 25.

Special Nutrition Program (SNP)

The major beneficiaries in the SNP are preschool children but pregnant and lactating mothers have also been included. The SNP was started in 1970 to 71. It is operated by the Ministry of Human Resource Development. It was originally launched as a Central Program and was transferred to the state sector during the fifth Five-Year Plan. The food is provided under the Minimum Needs Program. Funds for nutrition compound of ICDS are taken from the SNP budget.⁵⁴ *The objective* of the program is to improve the nutritional status of women, preschool children, pregnant women and lactating mothers in urban slums, tribal areas and drought prone rural areas. The two main activities of the program are:

1. To provide supplementary nutrition.
2. To provide health services, including supply of vitamin A solution and iron and folic acid tablets (Since 1975).

The aim is to provide 300 kcal and 10 to 12 g protein per day per child and 500 to 600 kcal and 20 g protein per day per woman. The SNP provides on the spot feeding 300 days per year.

Several studies have revealed that the target beneficiaries were not selected on the basis of severity of malnutrition. Also, the program lacked continuity and children were not fed for the required number of days in a year. Community involvement was conspicuously absent. In practice, the program is an ineffective exercise in offering foods to a selected group as charity.

Applied Nutrition Program (ANP)

The ANP was first introduced in 1960 in Orissa and Andhra Pradesh. It was extended thereafter to Tamil Nadu in 1961 and Uttar Pradesh in 1962. During 1973, it was extended to all the states. The three specific objectives of the program are:

1. To make people conscious of their nutritional needs.
2. To increase production of nutritious foods and their consumption.
3. To provide supplementary nutrition to vulnerable groups through locally produced foods.

The specific activities of the program are:

- Supplementary feeding.
- Nonformal preschool education.
- Nutrition education.
- Poultry farming.
- Beehive keeping.
- Providing better seeds and seedlings.
- Raising kitchen gardens.

The beneficiaries are children between 2 and 6 years and pregnant and lactating mothers. The children and women are given supplementary nutrition worth 25 paise per child per day and 50 paise per woman per day respectively. A single supplementary meal is given weekly for 52 days in a year. No definite nutrient content has been laid down for the food supplied.

Evaluation studies show that ANP has not generated the desired awareness for production and consumption of protective foods. The community kitchens and school gardens could not function properly. In reality, the program lacked effective supervision and has almost become defunct.

Mid-day Meal Program

The mid-day meal program was initiated in 1962 to 63 and was extended to the entire country in subsequent years.

The three specific objectives of the program are:

1. To raise the nutritional status of primary school children, particularly those belonging to low socio-economic group.
2. To improve attendance and enrollment in schools.
3. To prevent drop out from primary school.

The *specific activity* carried out under the scheme is to provide ready-to-eat food. The *beneficiaries* are children attending the primary school (6 to 11 years of age). The children belonging to backward classes, scheduled castes and scheduled tribes families are to be given priority. Ration for each beneficiary is presently budgeted at 50 paise per day and is aimed at providing 300 kcal and 8 to 12 g protein per day for 200 days in a year. 21.1 million beneficiaries were covered by 1989 to 99.⁵⁴

Most *evaluation* studies fail to reveal any significant increase in the levels of enrollment commensurate with the investment made on the scheme. The major bottlenecks include lack of continuity in the supply of food materials to the feeding centers, pilferage in the channels of distribution, non-adherence to the number of feeding days and absence of other health related activities. The mid-day meal has often been noticed to replace a meal at home and was generally no regarded as supplementary to what is consumed at home. Inadequate cooking and storage facilities at the schools and lack of local community involvement also contributed to its poor performance.

National IDD Control Program

The Government of India, launched the National Goitre Control Program (NGCP) in 1962. It aimed at replacement of ordinary salt by iodized salt, particularly in the goiter endemic regions. The program of universal iodization of edible salt was started from first April 1986 in phases with the aim of total salt iodization by 1992. In 1992, the NGCP was renamed as National Iodine Deficiency Disorders Control Program.

IODIZATION OF SALT

On 27.11.1997, the Govt. of India added Rule 44 H to the Prevention of Food Adulteration Rules, 1955, banning the sale of uniodized salt. This was considered as a positive step towards control of IDD. This was made effective on 27.5.98. This rule was deleted from the PFA rules. Govt of India with effect from 30-9-2000 vide orders dated 13-9-2000. This has been criticized.

The standards for iodized salt laid down in Appendix 15.01 of the PFA Rules are follows:

- Iodine content at manufacturer level—not less than 30 ppm on weight bases.
- Iodine content at retail level—not less than 15 ppm. Edible common salt (sodium chloride) is fortified by potassium iodide (Iodization) or potassium iodate (iodation) has been proved to be most acceptable

way to provide iodine to people. Using potassium iodate, the retention of iodine in the salt is increased considerably.

Why salt has been chosen?

(i) Salt is cheap, (ii) It can be readily manufactured in pure form, (iii) Salt is consumed by all, (iv) Its consumption rate per day per person is more or less constant and (v) It is technically easy and feasible to iodise salt in home and large industries.

‘Smiling Sun’ is imprinted for the illiterate to identify iodised salt.

Iodine in iodised salt can be ascertained by two methods i.e. Spot test in field condition and Iodimetry in a laboratory.

SPOT TEST

Spot test kit consists of two solutions kept in 3 polythene closed tubes – 2 tubes (white in color) contain test solution and 1 tube (red in color) contains recheck solution. At first one teaspoonful of salt is uniformly spread on a white piece of paper or a white plate. One or two drops of test solution are poured upon it; if the salt turns purple or blue it indicates presence of iodine. Then the color is matched with color chart either printed on the body of the kit or supplied separately within the kit. The spot matching to closely to one is the rough concentration of iodine in salt. Some salts which are more alkaline do not respond to test solution initially. For them at first 1 drop of recheck solution is given from the red tube and followed by 1 drop of test solution from white tube upon it. Purple or violet color would appear if iodine is present; if no color change develops even after this, then the salt contains no iodine.

The Central Government provides case grants for health education and publicity campaign for promoting the consumption of iodised salt. UNICEF and the Govt. of India have worked together for IEC activities related to NIDDCP in 106 selected districts of 13 states.⁵⁴

The Central Government also provides cash grants for establishing IDD Control Cells in the State Health Directorates. Most of them (26 states and UTs) have established these cells.⁵⁴

A National Reference Laboratory monitoring of IDD has been set up at the biochemistry division of the National Institute of Communicable Diseases, Delhi. It monitors the iodine content of salt and urine and treatise the medical and paramedical personnel monitoring laboratories have been established at the district level also in many districts. An allocation of Rs 75000/- per district laboratory has been provided for this purpose.

International Council for the control of Iodine Deficiency Disorders (ICCIDD), WHO and UNICEF recommend the progress of such program in any country needs to be monitored using quantifiable indicators. The indicators include (i) Proportion of

households consuming effectively iodised salt (>90%); (ii) Urinary iodine excretion: proportion below 100 mcg/lit (<50%) and proportion below 50 mcg/lit (<20%) and (iii) Thyroid size: proportion of school children 6–12 years age with enlarged thyroid, by palpation or ultrasound (<5%).⁵⁵

National Prophylaxis Program for Prevention of Blindness due to Vitamin A deficiency

Vitamin A deficiency has been recognized to be a major controllable public health and nutritional problem. In India, about 5.7% children suffer from eye signs due to vitamin A deficiency. Even mild vitamin A deficiency increases morbidity and mortality in children.

The national program for prophylaxis against blindness due to vitamin A deficiency was launched in 1970. In 1992, when CSSM program was launched, it was merged with the same currently, it forms part of this RCH program.⁵⁶

India was the first country to launch a national program of vitamin A distribution for prevention of blindness in children. Under the program, a massive dose of vitamin A is given once in six months to preschool children. Nutrition education to mothers aimed at promoting the consumption of vitamin A rich foods by the children is also given. The program is implemented through primary health centers and actual distribution is done by paramedical workers.

The *specific objective* of the program is reduction of disease and prevention of blindness due to vitamin A deficiency. An evaluation of the program has shown that in areas where it has been implemented well, there was significant reduction in the prevalence of signs of vitamin A deficiency. The reasons for poor coverage have been:

1. Inadequate supplies of vitamin A.
2. Adoption of clinic approach instead of house-to-house visit for the distribution.

National Prophylaxis Program for Prevention of Blindness due to Vitamin A deficiency comprises of a short term and long term strategy. Vitamin A supplementation has been proposed to be implemented through the primary health centers, its subcenters and the anganwadis. All health staffs working in the primary health centers are responsible for administering Vit A oil to children under 5 years of age and for imparting nutrition education. The services of ICDS program, under the Department of Women and Child Development, Ministry of Welfare is utilized for distribution of vitamin A to children in ICDS blocks and for education of the mothers and prevention of vitamin A deficiency.

Prevention of Vitamin A Deficiency

Promoting consumption of vitamin A rich food:

- Regular dietary intake of vitamin A rich foods by pregnant and lactating mothers and by children under 5 years of age is to be promoted. The mothers attending antenatal clinic and immunization session as well as mothers and children enrolled in the ICDS program are to be made aware of the importance of preventing vitamin A deficiency.
- Breast feeding, including feeding of colostrums is to be encouraged.
- Feeding of locally available beta-carotene rich food such as green leafy vegetables, yellow and orange vegetables and fruits like pumpkin, papaya, carrots along with cereal and pulse to be included in complementary feeding. In addition, consumption of milk, cheese, ghee, egg, liver, paneer, etc. are to be encouraged.

Administering supplemental dose of vitamin A:

- Unlike most other micronutrients, vitamin A is stored in the body for prolonged period and thus periodic administration of massive dose is required.
- Administration of supplemental dose of vitamin A to preschool children at periodic intervals is a simple, effective and most direct intervention short term strategy.
- Under this strategy, each infant 6–11 months and children 1–5 years is to be administered vitamin A every 6 months as follows:
 - 6–11 months: One dose of 100000 IU
 - 1–5 years: 200000 IU every 6 months.
 A child must receive a total of 9 oral doses of vitamin A by its fifth birthday.
- The first dose of vitamin A (100000 IU) is given along with measles vaccine between the ages of 9–12 months. Second dose (200000 IU) is given along with DPT/OPV booster between the ages of 16–24 months. Thereafter biannually the dose is administered up to the age of 5 years.
- Communication strategy for creating awareness about vitamin A must be in place.

Treatment of Vitamin A Deficient Child

Mild deficiency of vitamin A leads to night blindness and conjunctival xerosis, while severe deficiency results in corneal damage. The term 'xerophthalmia' is used to indicate different type of eye lesions that result from vitamin A deficiency. Xerosis can be completely reversed with vitamin A therapy but in untreated cases it progresses rapidly to keratomalacia ('wasting' of cornea) and blindness.

All children with clinical signs of vitamin A deficiency must be treated as early as possible. Treatment schedule is to administer 200000 IU of vitamin A immediately after diagnosis. This is followed by another dose of 200000 IU 1–4 weeks later. Infants and young children suffering from diarrhea, measles or acute respiratory infection must be monitored closely and encouraged to consume vitamin A rich food. In case, early signs of vitamin A deficiency are observed, the above treatment schedule must be followed.

Vitamin A syrup should be administered using the 2 ml spoon provided with each bottle of vitamin A. A full 2 ml spoon of vitamin A contains 200000 IU and marked level of 1 ml inside the spoon contains 100000 IU of vitamin A. Vitamin A concentrated solution are kept away from direct sunlight and stored at room temperature in a cold dark room for a minimum of 1 year. Once the bottle has been opened, it must be utilized within 6–8 weeks.

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National Nutritional Anemia Prophylaxis Program (NNAPP)

The National Nutritional Anemia Prophylaxis Program (NNAPP) was initiated in 1970 to control iron deficiency anemia in the vulnerable groups through daily supplements of iron-folic acid tablets. The suggested prophylactic doses of iron and folic acid tablets were distributed to the high risk groups by the local health workers. Other sustainable approaches to control anemia are food fortification and dietary diversification.

Infants between 6 and 12 months, school children 6 to 10 year old and adolescents 11 to 18 years old have also been included in this program, since sufficient evidence shows that iron deficiency affects this age group also. For children 6 to 60 months ferrous sulphate and folic acid are to be provided in a liquid formulation containing 20 mg elemental iron and 100 mcg folic acid per ml of liquid formulation. Dispersible tablets have an advantage over liquid formulation in programmatic conditions.⁵⁷

DEWORMING AND FOLIFER TABLET

There may be areas where iron folate tablets may not be effective due to heavy worm infestation. Whenever there is a history of worm infestation in mother or child, the iron folate tablets should be given after deworming. For pregnant mothers deworming should be done in the 2nd or 3rd trimester, but never in 1st trimester.

DOSE SCHEDULE OF IRON AND FOLIC ACID (IFA) IN DIFFERENT GROUPS

Categories	Dose schedule
6–60 months	20 mg elemental iron + 100 mcg folic acid per child per day for 100 days
6–10 years	30 mg elemental iron + 250 mcg folic acid per child per day for 100 days
11–18 years adolescents*	100 mg elemental iron + 500 mcg folic acid per adolescent per day for 100 days
Pregnant women	100 mg elemental iron + 500 mcg folic acid per women per day for 100 days
Lactating women	100 mg elemental iron + 500 mcg folic acid per women per day for 100 days

* Adolescent girls are given priority

In pregnancy IFA tablets are prescribed during the second half of pregnancy. If the mother is diagnosed anemic then 100 mg elemental iron + 500 mcg folic acid are given *twice daily* per day for 100 days; one tablet after lunch and one tablet after dinner. The tablet should be taken after meal and warm food or drinks, especially tea should be avoided for 2 hours after the intake of tablet. These IFA tablets are also given to family planning *IUD (intrauterine device) acceptors*.

Multiple channels and strategies are required to address the problem of iron deficiency anemia. Double fortified salts, sprinklers, ultra rice and other micronutrient candidates or fortified candidates are to be explored as an adjunct or alternate supplementation strategy. Two different technologies of fortification of common salt were developed at the NIN, Hyderabad as a long-term strategy to control and prevent iron deficiency anemia in the population. These are (i) iron fortified salt – common salt fortified with iron; and (ii) double fortified salt – common salt fortified with iron and iodine.⁵⁸

In depth studies carried out with this strategy have clearly shown that fortified salts improve hemoglobin status. Dietary diversification to improve absorption of iron by lowering inhibitor and increasing promoter concentrations has been suggested. This may need nutrition education and changes in dietary habits of the population.

Food Hygiene

Apart from diseases due to deficient or excess intake of food, there are diseases due to food contamination that occurs during production, storage, transport, cooking or feeding. In addition, there are diseases due to idiosyncrasy or allergy to certain foods in some individuals.

Food-borne or Food-related Diseases

- Diseases due to naturally present poisons in plants and animals: Examples are ergot, khesari dal, certain mushrooms and shellfish.
- Diseases due to chemical poisoning of food:

- *Accidental*: As in use of insecticides like sodium fluoride used for killing cockroaches, ants, etc. The poison resembles flour in appearance.
- *Due to adulteration*: For example mixing of mineral oils and argemone oil to edible oils.
- *Intentional*: Done with malice (homicidal), e.g. mixing of arsenic in milk or other food, or forethought (suicidal), e.g. taking of potassium cyanide, diazinon, etc.
- *Disease due to biological agents*: They may be due to specific infections, bacterial toxins or parasites.
 - Due to specific infections: Common ones are enteric fever, amebiasis, giardiasis and brucellosis.
 - Due to bacterial toxins: Food gets contaminated with microorganisms, which grow in the food and produce toxins. Such food produces symptoms of food poisoning. Common contaminants are *Staphylococcus*, *Cl. welchii* and *Cl. botulinum*.
 - Due to parasites: Tapeworms, flukes, roundworm, whipworm and trichinellosis spread through food contamination.
- *Diseases due to food allergy*: Some persons have inherent or acquired idiosyncrasy to certain foods, i.e. some foods do not agree with them and if they take such foods, they get digestive upsets, urticaria or asthma. The foods to which a person is allergic are mostly protein in nature such as eggs, fish, shellfish, milk and less commonly, pulses and some vegetables and fruits.

PREVENTION AND CONTROL

Diseases due to contamination of food can be prevented by proper food sanitation or hygiene, the principles of which are given below. Hygienic preparation of milk and meat and preservation of eggs, fish and vegetable food has already been discussed under respective headings.

Protection against Contamination

Foods, drinks and milk, when produced, stored, transported, cooked or served, should be free from all sorts of contamination with germs or any other harmful material. The workers should observe strict cleanliness. The utensils should be clean. The kitchen should be insect-free, rodent-free, dust-free and otherwise clean in general. Medical examination of workers should be done to find if they are carriers of some disease like typhoid and dysentery. If so, they should be stopped from handling food and should be given appropriate treatment.

Protection against Toxins

Cl. botulinum cannot produce toxin at temperature below 10°C. *Salmonella* and staphylococci do not grow at temperature below 5° to 6°C. They can grow at

temperature from 6-7° to 45°C, so refrigeration can prevent their growth. *Salmonella*, staphylococci and *Cl. welchii* poisoning can be avoided by proper cooking of food and serving it hot. The time between cooking and serving should be short so as to prevent the growth of these organisms. If food is stored after cooking, this should be done at low temperature or above 50°C. In order to destroy exotoxins of *Cl. botulinum*, food should be heated to 80°C for 15 to 30 minutes before serving. This is particularly so in case of canned non-acid foods. The formation of *Cl. botulinum* toxins is inhibited in acid foods with pH less than 4.5.

The exotoxin of *Staphylococcus* is heat stable and is destroyed at 191°C for 30 minutes, which is not possible in practice. Cream and custard filled pastries and dahi from contaminated milk may cause such poisoning. Hence it is advisable to boil milk and to keep it free from growth of germs by refrigeration. Staphylococcal carriers (often nasal and skin carriers) should not handle milk and meat preparations.

Prevention of Adulteration

Prevention of Food Adulteration Act, 1954 and Prevention of Food Adulteration Rules, 1955 provide for prevention of adulteration and inspection of food by Inspectors and Health Officers. Poisoning due to commercial fraud is often reported in newspapers. The Act should be strictly explained and regular inspection of all foods and food establishments should be done.

Control over Food Establishments

Slaughter houses, flour mills, bakeries, confectioneries, creameries, sweetmeat shops, biscuit factories, icecream plants, pasteurizing plants and ice and aerated water factories are often found in small towns without any control whatsoever. In bigger towns, they are controlled through a licensing procedure but the control is poorly exercised. The owners, managers and workers are often indifferent and apathetic to or ignorant of hygienic principles. To make them observe or follow the same, the food law administration needs to be strengthened by providing more staff as well as stringent punishment.

National Nutrition Policy

The Government of India announced the National Nutrition Policy (NNP) in the second half of 1993. It is a 22 page document consisting of 12 pages in text and 10 pages in annexure and tables, etc. The policy has been published by the Deptt. of Women and Children, Ministry of Human Resource Development. An extract of the policy is given below. Numbering of the paras and subparas has been retained as in the original for purpose of reference.

Introduction

Widespread poverty resulting in chronic and persistent hunger is the single biggest scourge of the developing world today. The physical expression of this continuously reenacted tragedy is the condition of undernutrition which manifests itself among large sections of the poor, particularly amongst the women and children. This condition of undernutrition, therefore, reduces work capacity and productivity amongst adults and enhances mortality and morbidity amongst children. Such reduced productivity translates into reduced earning capacity, leading to further poverty, and the vicious cycle goes on.

The nutritional status of a population is therefore critical to the development and well being of a nation.

Need for a Nutrition Policy within the Development Context

The need for a National Nutrition Policy is implicit in both the paramountcy of nutrition in development as well as in the complexity of the problem. This general problem of undernutrition should be seen as a part of a larger set of processes that produces and consumes agricultural commodities on farms, transforms them into food in the marketing sector and sells the food to customers to satisfy nutritional, aesthetic and social needs. Within this set, there are three subsets of issues, within the broad sectors of agriculture, food and nutrition, with various linkages among them. In fact, the third subset, viz. nutrition, is the net result of the other two subsets.

It is both possible as well as necessary to devise policy interventions for influencing the working of these sets and thereby improving the nutritional status of the society. Increased food production does not by itself necessarily ensure nutrition for all. According to the 1987-88 round of NSS, nearly 29.2% of India's population is estimated to be below the defined poverty line. While, at the macro-level, this group constitutes the nutritionally at risk population, even within this group the women and the children represent nutritionally the most fragile and vulnerable sections. This is the result of intrahousehold gender discrimination, which perpetuates the age old inequities. All this emphasises the complexity of the problem and the need for tackling the Nutrition Policy consciously and at several levels simultaneously. Mere economic development, or even the adequacy of food at household levels, are no guarantees for a stable and satisfactory nutritional status. At the same time, however, the overall development strategy of a country is likely to have a pronounced bearing on what nutritional planning can accomplish. Therefore, the task is not merely in terms of formulating a nutritional policy but also in terms of locating and grounding it in the overall development strategy of the

country. Nutrition has to be tackled independently, along with other development issues. This is not all. The time dimension is also important. A policy having a mere long-term effect, even if beneficial for the nutritionally at risk population, would not suffice. After all, this group has too little to live on in the long run and has too much to die of in the short run. Therefore, both short as well as long-term strategies are called for, comprising both direct as well as indirect interventions.

The Nutrition Status of India

THE AGGREGATE POSITION REGARDING INTAKE

Calorie and protein intake: There has been a steady increase in aggregate consumption of calories at household level. During 1957-79, in urban areas, the aggregate intake levels of protein were above the ICMR recommended level for all income groups except slum dwellers. Even in rural areas, between 1975 and 1989, aggregate consumption levels of all groups taken together were higher than the recommended levels. In fact, time trends show that the average intake of calories at the lowest income group had a definite increasing trend during the seventies. However, there has not been a commensurate increase in consumption of proteins and protective foods like fats and oils.

Micronutrient intake: During 1975-79, in urban areas, aggregate intake levels of iron were above the ICMR recommended levels for all income groups. For vitamin A, however, deficiencies existed among all groups except the high income groups.

THE DISAGGREGATED PICTURE

Although, the NNMB reports regarding average household food consumption levels do not point to any significant intake shortfall except for vitamin A, these average figures actually mask the real picture. According to a NNMB-NSSO survey, even at an aggregate level in terms of monthly households income, around 35% of households earn considerably less than the average food expenditure of the sampled families.

Thus, even though there has been a drop in the population below poverty line since 1960 (from 56.8% to 29.2% in 1987-88) in terms of numbers, a staggering 250 million people suffer from varying degrees of malnutrition in India. There is, however, no doubt that the impressive gains of the Green Revolution in terms of national food security and effective early warning systems have eradicated famines and situations of extreme hunger and starvation. What still remain are different degrees of chronic and endemic hunger which, in the context of prevailing patterns of intra-household food distribution, particularly in rural families, translate into a grave danger for the nutritional status of women

and children. This is the crux of the nutrition situation in India.

The major nutritional problems of India can be discussed under the following headings:

UNDERNUTRITION

- *Protein energy malnutrition:* It is the most widespread form of malnutrition among preschool children of our country. A majority of them suffer from varying grades of malnutrition. As many as 43.8% children suffer from moderate degrees of PEM and 8.7% suffer from severe extreme forms of malnutrition. Surveys conducted between 1975 and 1990 indicated that the percentage of normal children (for both the sexes pooled) has increased from 5.9% to 9.9% while the moderate form of malnutrition declined from 47.5 to 43.8%. The child population of urban slums had the lowest proportion of children with normal body weight and recorded the highest proportion of severely malnourished children.
- *Iron deficiency nutritional anaemia:* Nutritional anaemia among the preschool children and expectant and nursing mothers is one of the major preventable health problems in India. It has been estimated in various studies, particularly those conducted by NIN, that roughly 56% preschool children and almost 50% of the expectant mothers in the third trimester of pregnancy suffer from iron deficiency, which is basically due to inadequate or poor absorption of iron from a predominantly cereal-based diet. Low iron intake, coupled with hookworm infestation and infections, further aggravates the problem.
- *Iodine deficiency disorders:* In India, nearly 40 million persons are estimated to be suffering from goitre and 145 million are living in the known goitre endemic regions. The prevalence of goitre in these endemic regions ranges from 1.5% in Assam (Cachar Distt) to 68.6% in Mizoram. It is also estimated that 2.2 million children are afflicted with cretinism and about 6.6 million are mildly retarded and suffer from varied degrees of motor handicaps. It is estimated that iodine deficiency also accounts for 90,000 stillbirths and neonatal deaths every year.
- *Vitamin A deficiency:* Night blindness, which affects over seven million children in India per year, results mainly from the deficiency of vitamin A, coupled with protein energy malnutrition. In its severest form, it often results in loss of vision and it has been estimated that around 60,000 children become blind every year. While there are no manifestations of vitamin A deficiency in infants, its prevalence increases with age. A higher prevalence was seen in school age children in all the income groups. In the urban areas, it is the highest among slum children (7.8%). According to NNMB (1990), in none of the

states was the average intake comparable to the recommended level.

- *Prevalence of low birth weight children:* The prevalence of low birth weight children is still unacceptably high for India. The nutritional status of infants is closely related to the maternal nutritional status during pregnancy and infancy. In India, 30% of all the infants born are low birth weight babies (Weight less than 2500 g) and this pattern is almost constant since 1979. Low birth weight was found to be connected with several factors such as age of the mother, maternal weight, weight gain during pregnancy, interpregnancy interval, hemoglobin less than 8 g% and maternal illiteracy.

SEASONAL DIMENSIONS OF NUTRITION

In the duality of the Indian situation, where high-yielding modern agriculture co-exists with rain-fed subsistence farming, there are serious seasonal dimensions of the nutrition question. In large parts of India, the rainy months are the worst months for the rural, landless poor. This is when cultivation, weeding, ploughing and other works demand maximum energy from them, while food stocks at home dwindle and market prices rise. These are again the months when waterborne diseases are so frequent. This condition goes on aggravating till late October or even November. These are the months of rural indebtedness and compulsive market involvement of the landless and the small/marginal cultivators. When the first kharif harvest arrives, the situation is no better with widespread distress sales by the small/marginal farmers. All these make nutrition a casualty during this period. Seasonality of employment in subsistence agriculture affects nutrition through the double jeopardy of high energy demand of peak work seasons and fluctuation in household level food availability, which tend to exacerbate differential food intake among men, women and children. As a result, in very poor households, women and children may actually fall below the survival line during lean periods.

NATURAL CALAMITIES AND NUTRITION

This same group of rural landless poor is most vulnerable to droughts, floods and famines. As has been established in famine periods, worst affected groups are the landless agricultural labourers, artisans, craftsmen and nonagricultural laborers in that order.

EFFECT OF MARKET DISTORTION AND DISINFORMATION

A striking feature which has now been established is that famines are caused not so much by any real decline in food availability as by a sudden erosion of purchasing power of those marginal groups who compulsively depend on the market (landless laborers, etc.). In fact,

lessons from all over the world have proved that it is not any substantial food shortage, but the psychosis of food shortage and the widespread belief regarding crop failure, that triggers off price rise spirals resulting in major malnutrition situations.

URBANIZATION

Undernutrition in urban areas is a major area of concern. Studies by NNMB have actually shown that the nutritional status of urban slum dwellers in India is almost as bad as that of rural poor. This is borne out both by figures relating to intake of food as well as intake of nutrients. The deleterious effects of rural urban movements on nutrition in much of the third world are quite well known. Urban culture, which encourages division of a high proportion of family expenditure to luxury goods and entertainment, aggravates the situation. Poor sanitary conditions, acute respiratory infections and communicable diseases characterize these urban settlements.

NUTRITION PROBLEMS OF SPECIAL GROUPS

There are some regional and occupational specificities of the problems of nutrition. The nutritional imbalance of hill people engaged in very strenuous labor and the special nutritional problems of some categories of industrial workers and migrant workmen are some examples which need a detailed and specific response.

OVERNUTRITION AND OBESITY

With the burgeoning size of Indian middle class, over-nutrition and obesity, with attendant problems of cardiovascular disease and other health hazards, are affecting a large number of people, particularly in the cities.

The Existing Policy Instruments for Combating Malnutrition

Till the end of the Fourth Plan, India's main emphasis was on the aggregate growth of the economy and reliance was placed on the percolation effects of growth. In the face of continuing poverty and malnutrition, an alternative strategy of development, comprising a frontal attack on poverty, unemployment and malnutrition, became a national priority from the beginning of the V Plan. This shift in strategy has given rise to a number of interventions to increase the purchasing power of the poor, to improve the provision of basic services to the poor and to devise a security system through which the most vulnerable sections of the poor (viz., women and children) can be protected. The various intervention programs, that we already have, are given in Annexure-I.

Nutrition Policy Instruments

The strategy: Nutrition is a multi-sectorial issue and needs to be tackled at various levels. Nutrition affects development as much as development affects nutrition. It is, therefore, important to tackle the problem of nutrition, both through direct nutrition intervention for specially vulnerable groups as well as through various development policy instruments which will create conditions for improved nutrition.

DIRECT INSTRUMENTS: SHORT-TERM INTERVENTIONS

Nutrition Intervention for specially vulnerable groups:

- *Expanding the safety net:* The Universal Immunization Program, Oral Rehydration Therapy and the Integrated Child Development Services (ICDS) have had a considerable impact on child survival (IMR for 1989 stood at 91 per 1000) and extreme forms of malnutrition. The position, however, is that the silent form of hunger and malnutrition continues with over 43.8% (1988-90) children suffering from moderate malnutrition and about 37.6% (1988-90) from mild malnutrition. Therefore, while more children are surviving today, an overwhelmingly large number of them are destined to remain much below their genetic potential. This is the enormity of the demographic trap which faces us as we move towards the next century. There is, therefore, an immediate imperative to substantially expand the nutrition intervention net through ICDS so as to cover all vulnerable children in the age group 0 to 6 years. Presently India's child population for 0 to 6 years is around 18% of the total population and, out of this, 30.76 million comprise the children from the households living below the poverty line in rural areas. Presently ICDS covers around 15.3 million children (most of them in the rural areas). It should be our conscious policy to cover the remaining 15.46 million children, who are nutritionally at risk, by extending ICDS to all the remaining 2388 blocks (5153 minus 2765 blocks existing) of the country by the year 2000.
- *Behavioural changes:* With the objective of reducing the incidence of severe and moderate malnutrition by half by the year 2000 AD, a concerted effort needs to be made to trigger appropriate behavioral changes among the mothers. Improving growth monitoring between the age group 0 to 3 years in particular, with closer involvement of the mother, is a key intervention. Presently, growth monitoring has become a one-way process and the mothers are mere passive observers of the entire process. This needs to be changed because, after all, nutrition management of the children will have to be done

by the others at home. Getting involved in the growth monitoring of her child will give her a feeling of control over the child's nutrition process and, combined with adequate nutrition and health education, empower her to manage the nutrition needs of her children effectively.

- *Reaching the adolescent girls:* The government's recent initiative of including the adolescent girl within the ambit of CDS should be intensified so that they are made ready for a safe motherhood, their nutritional status (including iron supplementation) is improved and they are given some skill upgradation training in home-based skills and covered by non-formal education, particularly nutrition and health education. All adolescent girls from poor families should be covered through the ICDS by 2000 AD in all CD blocks of the country and 50% of urban slums.
- *Ensuring better coverage of expectant women:* In order to achieve a target of 10% incidence of low birth weight by 2000 AD, such coverage should include supplementary nutrition right from 1st trimester and should continue during the major period of action, at least for the first one year after pregnancy.

Fortification of essential foods: Essential food items shall be fortified with appropriate nutrients, for example, salt with iodine and/or iron. However, given the highly extensive and decentralised process of salt marketing in the country, there is the need to identify a vehicle which can be better controlled. Research in iron fortification of rice and other cereals should be intensified. The distribution of iodised salt should cover all the population in endemic areas of the country to reduce the iodine deficiency to below endemic levels.

Popularization of low cost nutritious foods: Efforts to produce and popularize low cost nutritious foods from indigenous and locally available raw material shall be intensified. It is necessary to involve women particularly in this activity.

Control of micronutrient deficiencies amongst vulnerable groups: Deficiencies of vit. A, iron and folic acid and iodine among children, pregnant women and nursing others shall be controlled through intensified programs. Iron supplementation to adolescent girls shall be introduced. The program shall be expanded to cover all eligible members of the community. The prophylaxis programs, at present, do not cover all children. For example, the vit. A program covers only 30 out of about 80 million. It is necessary to intensify all these efforts and work on a specific time frame. Nutritional blindness should be completely eradicated by the year 2000 AD. The Nutritional Anemia Prophylaxis Program should be extended and strengthened to reduce anaemia in expectant women to 25% by 2000 AD.

INDIRECT INSTRUMENTS: LONG-TERM INSTITUTIONAL AND STRUCTURAL CHANGES

Food Security: In order to ensure aggregate food security, a per capita availability of 215 kg/person/year of food grains needs to be attained. This requires production of 250 million tonnes of food grains per year by 2000 AD and buffer stocks of 30 to 35 million tonnes in order to guard against exigencies, such as flood and droughts. However, taking into account the present trends and the possibility of improved availability of noncereal food items, there should be a target of at least attaining 230 million tonnes food grains production by 2000 AD. The production of food grains (cereals, pulses and millets) in 1988-89 was 172 million tonnes.

Improvement of dietary pattern through production and demonstration: Dietary pattern will be improved by promoting the production and increasing the per capita availability of nutritionally rich foods. The production of pulses, oilseeds and other food crops will be increased with a view to attaining self-sufficiency and building surplus and buffer stocks. The production of protective foods, such as vegetables, fruits, milk, meat, fish and poultry, shall be augmented. Preference shall be given to growing foods, such as millets, legumes, vegetables and fruits (carrots, green leafy vegetables, guava, papaya and amla). For this purpose, the latest and improved techniques shall be increasingly applied, high-yielding varieties of food crops developed and extensively cultivated, adequate extension services made available to farmers, wastage of food in transit and storage reduced to the minimum, available food conserved and effectively utilized and adequate buffer stocks built up. Certain imbalances and anomalies in our agricultural policy need to be redressed immediately. Our Agricultural Policy has been hitherto concerned with production exclusively and not nutrition, which is the ultimate end. The Green Revolution has largely remained a cereal revolution, with bias towards wheat. Coarse grains and pulses, which constitute the poor man's staple and protein requirements, have not received adequate attention. The prices of pulses, which were below cereal prices before the Green Revolution, are now almost double the price of cereals. Our Food Policy should be consistent with our national nutritional needs and this calls for the introduction of appropriate incentives, pricing and taxation policies.

Policies for Effecting income transfers so as to improve the entitlement package of the rural and urban poor:

- *Improving the purchasing power:* Poverty alleviation programs, like the Integrated Rural Development Program (IRDP) and employment generation

schemes like Jawahar Rozgar Yojana, Nehru Rozgar Yojana and DWCRA are to be reoriented and restructured to make a forceful dent on the purchasing power of the lowest economic segments of the population. In all poverty alleviation programs, nutritional objectives shall be incorporated explicitly. Existing programs shall be scrutinized for their nutrition component. It is necessary to improve the purchasing power of the landless and the rural and urban poor by implementing employment generation programs so that additional employment of at least 100 days is created for each rural landless family and employment opportunities are created in urban areas for slum dwellers and the urban poor.

- **Public distribution system:** Ensuring an equitable food distribution, through the expansion of the public distribution system. The public distribution system shall ensure availability of essential food articles, such as coarse grains, pulses and jaggery, besides rice, wheat, sugar and oil, conveniently and at reasonable prices to the public, particularly to those living below the poverty line, not only in urban areas but throughout the country. For this purpose, encouragement shall be given to the consumer cooperatives and fair price shops shall be opened in adequate number in all areas. Effective price and quality control shall be exercised over the cooked foods in restaurants and other eating places.

The public distribution system should be strengthened, especially during the monsoon months, for giving special rations at specially subsidized rates for at least four months (July-October) to the seasonally “at risk” population. The beneficiaries of this program should include landless laborers and their families and the migrant laborers and their families.

Land Reforms: Implementing land reform measures so that the vulnerability of the landless and the landed poor could be reduced. This will include both tenural reforms as well as implementation of ceiling laws.

Health and family welfare: The health and family welfare programs are an inseparable part of the strategy. Through “Health for All by 2000 AD” program, increased health and immunisation facilities shall be provided to all. Improved prenatal and postnatal care to ensure safe motherhood shall be made accessible to all women. The population in the reproductive age group shall be empowered, through education, to be responsible for their own family size. Through intensive family welfare and motivational measures, small family norm and adequate spacing shall be encouraged so that the food available to the family is sufficient for proper nutrition of the members.

Basic health and nutrition knowledge: Basic health and nutrition knowledge, with special focus on wholesome infant-feeding practices, shall be imparted

to the people extensively and effectively integrated into the school curricula, as well as into all nutrition programs. Nutrition and Health Education are very important in the context of the problems of overnutrition also.

Prevention of food adulteration: Prevention of food adulteration must be strengthened by gearing up the enforcement machinery.

Nutrition surveillance: Nutrition surveillance is another weak area requiring immediate attention. The NNMB/NIN of ICMR needs to be strengthened so that periodical monitoring of the nutritional status of children, adolescent girls, and pregnant and lactating mothers below the poverty line takes place through representative samples and results are transmitted to all agencies concerned. The NNMB should not only try and assess the impact of ongoing nutrition and development programs but also serve as an early warning system for initiating prompt action. Since the department of women and child development is the nodal department for national nutrition policy, it is necessary for the NNMB to be accountable to this department in so far as nutrition surveillance is concerned.

Monitoring of nutrition programs: Monitoring of Nutrition Programs (viz. ICDS), and of Nutrition Education and Demonstration by the Food and Nutrition Board, through all its 67 centers and field units, should be continued. The transfer of Food and Nutrition Board to the Department of Women and Child Development has already been approved by the Prime Minister. This will ensure an integrated set up to deal with the problem of nutrition with adequate technical and field level set up.

Research: Research into various aspects of nutrition, both on the consumption side as well as the supply side, is another essential aspect of the strategy. Research must accurately identify those who are suffering from various degrees of malnutrition. Research should enable selection of new varieties of food with high nutrition value which can be within the purchasing power of the poor.

Equal remuneration: Special efforts should be made to improve the effectiveness of programs related to women. The wages of women shall be at par with those of men in order to improve women’s economic status. This requires a stricter enforcement of the Equal Remuneration Act. Special emphasis will have to be given for expanding employment opportunities for women.

Communication: Communication through established media is one of the most important strategies to be adopted for the effective implementation of the Nutrition Policy. The Department of Women and Child Development will have a well-established, permanent communications division, with adequate staff and fund support. While using the communication tools, both mass communication

as well as group or interpersonal communication should be used. Not only the electronic media but also folk and print media should be used extensively.

The role of information is crucial for nutrition. Such information is not only important with regard to improved health and nutrition practices but can also have a vital influence on the market, particularly during natural calamities, war, etc. The role of information during such exigencies is to ensure that the market remain stable without any panic being created. This also needs to be carefully monitored.

Minimum Wage Administration: Closely related to the market, is the need to ensure an effective, minimum wage administration to ensure its strict enforcement and timely revision and linking it with price rise through a suitable nutrition formula. A special legislation should be introduced for providing agricultural women laborers the minimum support, and at least 60 days leave by the employer in the last trimester of her pregnancy.

Community Participation: The active involvement of the community is essential not only in terms of being aware of the services available to the community but also for deriving the maximum benefit from such services by giving timely feedback necessary at all levels. After all, communication must form an essential part of all services and people themselves are the best communicators. Community participation will include:

- Generating awareness among the community regarding the National Nutrition Policy and its major concerns.
- Involving the community through their Panchayats or, where Panchayats do not exist, through beneficiary committees in the management of nutrition programs, and interventions related to nutrition, such as employment generation, land reforms, health, education, etc.
- Actual participation, particularly of women, in food production and processing activities.
- Promoting schemes relating to kitchen gardens, food preservation, preparation of weaning foods and other food processing units, both at the home level as well as the community levels.
- Generation of effective demand at the level of the community for all services relating to nutrition.

Education and literacy: It has been shown that education and literacy, particularly that of women, is a key determinant for better nutritional status. For instance, Kerala, which has the highest literacy level, also has the best nutrition status despite the fact that calorie intake in Kerala is not the highest among all States in the country.

Improvement of the status of women: The most effective way to implement nutrition with mainstream activities in Agriculture, Health, Education and Rural Development is to focus on improving the status of

women, particularly the economic status. After all, women are the ultimate providers of nutrition to households, both through acquisition of food as well as preparation of food for consumption. There is evidence that women's employment does benefit household nutrition, both through increase in household income as well as through an increase in women's status, autonomy and decision making power. Moreover, female education also has a strong inverse relationship with IMR. Educated women have greater roles in household decision making, particularly those relating to nutrition and feeding practices.

Therefore emphasis on women's employment and education, particularly nutrition and health education, should provide the bedrock of the nation's nutritional intervention. If a self-sustaining development model is to be pursued in which the community is able to manage its nutrition and health needs on its own, the socioeconomic security of women is sine qua non. This underscores the importance of improving the employment status of women. The grounds well of voluntary action created through the National Literacy Mission should be harnessed and channelised into the areas of child survival and nutrition.

Administration and Monitoring

IMPLEMENTATION OF NATIONAL NUTRITION POLICY

The measures enumerated above have to be administered by several ministries/departments of the Government of India and various governmental and non-governmental organizations. There should be a close collaboration between the Food Policy, Agricultural Policy, Health Policy, Education Policy, Rural Development Program and Nutrition Policy as each complements the other.

The NNP should immediately be translated into forceful, viable and realistic sectoral action programs. Special working groups shall be constituted in the Deptts. of Agriculture, Rural Development, Health, Education, Food and Women and Child Development to analyze the nutritional relevance of sectoral proposals and to incorporate nutritional considerations in the light of the Nutrition Policy wherever necessary. Each concerned Central Ministry shall implement the measures for which it has direct or nodal responsibility.

An interministerial coordination committee will function in the Ministry of Human Resource Development under the Chairmanship of Secretary, Department of Women and Child Development, to oversee and review the implementation of nutrition intervention measures. Sectoral Ministries/Deptts concerned, like Health and Family Welfare, Education and Agriculture, Food and Civil Supplies, etc. will be represented on the interministerial coordination Committee. The Committee will meet once or twice a

year. The Coordination Committee would be constituted with the sectoral representatives or administrators essential for decision making on policy matters. To analyse, discuss and resolve the technical issues and nutrition aspects of all plans and strategies during the implementation stage, technical experts from concerned areas would be associate members.

A National Nutrition Council will be constituted in the Planning Commission, with Prime Minister as President. Members will include concerned Union Ministers, a few State Ministers by rotation and experts and representatives of nongovernmental organizations. The Council will be the national forum for policy coordination, review and direction at the national level. The Council will meet once a year. The National Nutrition Council will be the highest body for overseeing the implementation of the National Nutrition Policy through the various sectoral plans of action and will issue policy guidelines based on latest nutritional surveillance feedback.

MONITORING OF NUTRITION SITUATION

Nutritional surveillance of the country's population, especially children and mothers, shall be the responsibility of the National Institute of Nutrition/NNMB who, in turn, may involve the National Institute of Health and Family Welfare, Central Health Education Bureau, Home Science and Medical Colleges and NGOs. There shall be a mechanism to utilize the services of Food/Nutrition Science and Medical graduates trained every year, to manage the national nutrition programs. NIN/NNMB should be accountable to the Deptt of Women and Child Development in so far as nutrition surveillance is concerned.

The paucity of reliable and comparable data from all parts of the country is a definite obstacle towards a realistic and disaggregated problem definition. This calls for a Nationwide Nutrition Monitoring Bureau (NNMB) and to develop a mechanism for generating nationwide disaggregated data within a short period for use by the Central and the States for taking corrective action wherever necessary. This would ensure a regular monitoring and surveillance system and develop a reliable data base in the country, not only to assess the impact of on-going nutrition and development programs, but also to serve as an early warning system for initiating prompt action.

ROLE OF STATE GOVERNMENTS

In a federal polity like ours, the cutting edge of governmental interventions commences from the state level. Therefore, the successful actualization of Nutrition Policy is largely dependent on the effective role of the State Governments.

The formal structure at the State level should be similar to that envisaged under the Government of

India. There should be an apex State level nutrition council to be chaired by the Chief Minister and comprising of the concerned Ministers of the State Government, representatives of leading NGOs working in the state, experts and representatives of related professional bodies. There should be an Inter-departmental Coordinating Committee to function under the Chief Secretary which will coordinate, oversee and monitor the implementation of the National Nutrition Policy. The Committee would also focus on the State level targets for the various nutrition related indicators based on targets set under the NNP. The Secretary of the Department dealing with women and children should be the convener of this Committee.

Special working groups will be set in the Departments of Agriculture, Rural Development, Health, Education, Food and Women and Child Development and these group will be responsible for vetting the various sectoral schemes from the point of view of nutrition before they are finalized.

COMMUNITY MOBILIZATION

Given the problem of mounting delivery cost of various nutrition interventions, it is necessary to mobilize resources from within the community in order to ensure sustainability of these interventions. This is a major area of concern and the State Governments, local bodies (including Municipal and Panchayat bodies); NGOs, cooperatives and professional organizations and pressure groups must take this up as a challenge. In a pluralistic society like ours, a concerted effort by all of them is the only way to build community support and, ultimately, community participation in these schemes. Successful examples of the community contributing the nutrition component of ICDS scheme exists in certain states. It is possible to replicate these examples. Many State Governments have started a major Mid-day Meal Program funded out of the state resources. The other State Governments/ Union Territory Administration may also consider such an introduction in their primary and secondary schools. The private schools and schools which are capable of mobilizing their own resources may be encouraged to introduce such schemes out of their own resources.

The State Governments may consider constituting similar bodies, i.e. State Coordination Committees and State Nutrition Councils, as well as such bodies at the district levels.

In a massive country like India, with autonomous states, each with its characteristic problems, priorities, approaches and resources, the state level nutrition policies would be better able to deal with the problems. After the NNP of India is operationalized with specific objectives, plans of action, strategies, targets and time frame, development of state level policies shall be encouraged.

WORLD FOOD DAY—OCTOBER 16, 2009

World Food Day is celebrated every year on 16th October, commemorating the founding of the Food and Agriculture Organization (FAO) in 1945. It was proclaimed in 1979 with the aim to increase public awareness of the world food problem, hunger, malnutrition and poverty. Dr Pál Romány, a Hungarian, was the key man behind this event. 'Achieving Food Security in Times of Crisis' is the theme for this year.

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Biostatistics

Any branch of science demands precision for its development and medical science is no exception. With the scientific advances in modern medicine, including public health, there has been felt an increasing need for objectivity, so that data may be properly processed and correctly interpreted, leading to conclusions that may stand the tests of significance. Even before the observations are made and data collected, experiments have to be designed and surveys planned keeping in mind the subsequent statistical analysis of data. That is why it is very important for all students and practitioners of medicine, especially those of community medicine, to have a working knowledge of biostatistics. The present chapter can at best be regarded as an introductory overview of statistics as used in medicine. It is strongly recommended that the more serious student should read an appropriate textbook suitable to his taste and needs.¹⁻⁴

Statistics is the science of compiling, classifying and tabulating numerical data and expressing the results in a mathematical or graphical form. *Biostatistics* is that branch of statistics concerned with mathematical facts and data relating to biological events. *Medical statistics* is a further specialty of biostatistics when the mathematical facts and data are related to health, preventive medicine and disease. *Vital statistics* is that branch of statistics that deals mainly with births, deaths, human populations and the incidence of disease.⁵

First of all, we shall enumerate the uses of biostatistics and the sources of data. The subsequent discussion in this chapter will be related to six topics, viz. Presentation of statistics, Variability and error, Analysis and interpretation of data, Sampling, Sampling variations and Tests of significance.

Uses of Biostatistics

- To define normalcy
- To test whether the difference between two populations, regarding a particular attribute, is real or a chance occurrence.
- To study the correlation or association between two or more attributes in the same population.
- To evaluate the efficacy of vaccines, sera, etc. by control studies.

- To locate, define and measure the extent of morbidity and mortality in the community.
- To evaluate the achievements of public health programs.
- To fix priorities in public health programs.

Sources of Data

- Experiments performed in the laboratory or in the wards.
- Surveys and epidemiological investigations carried out by trained teams in the field to investigate health problems.
- Records like birth and death registers and other medical records in hospitals.

The figures from the above sources are obtained either by measurement or by enumeration. The data collected by measurement are called continuous data as in case of height, weight, blood pressure, etc. The data collected by counting are called discrete data, e.g. the number of persons dying or cured of a particular disease. Continuous data are numerically measurable, such as the height of persons. The term continuous indicates that there is no natural demarcation between different categories. Thus two persons may be 165 cm and 166 cm tall respectively, but there may be persons 165.3 cm and 165.7 cm tall between these two values. On the other hand, data having an inbuilt natural demarcation are called discrete, such as blood groups A, B, O and AB.

Different Scales of Measurement

There are four different measurement scales, i.e. (i) Nominal (ii) Ordinal (iii) Interval and (iv) Ratio scales.

NOMINAL SCALE

Nominal scale is the least powerful among all the measurement scales. It is simply a system of assigning number to events in order to label them, i.e. assignment of numbers to cricket players in order to identify them. Here data is divided into qualitative categories or group (thus counted data), in other words nominal data can be grouped but not ranked. For example, male/female,

urban/rural, right/left, yes/no and 0/1 are examples of nominal data. Among the measures of central tendency, only mode can be applied over nominal scale. Chi-square test is the most common test of statistical significance that can be utilized in this scale.

ORDINAL SCALE

Among the three ordered scales, i.e. ordinal, interval and ratio scale, ordinal scale occupies the lowest level, e.g. ordinal < interval < ratio. This scale places events in a meaningful order (ARI may be classified as no pneumonia, pneumonia, severe pneumonia and very severe disease). But here no attempt is made about the size of interval, i.e. no conclusion about whether the difference between first and second grade is same as the difference between second and third grade. We can not say (very severe disease – severe pneumonia = pneumonia – no pneumonia). Thus ordinal scale only permits ranking of items from highest to lowest.

INTERVAL SCALE

Similar to ordinal scale, here data can be placed in meaningful order, and in addition, they have meaningful intervals between them. The intervals can also be measured. In Celsius scale, 100° to $90^{\circ}\text{C} = 60^{\circ}$ to 50°C . But this scale does not have absolute zero (an arbitrary zero point is assigned), so 100°C is not equal to twice 50°C ($100^{\circ}\text{C} \neq 2 \times 50^{\circ}\text{C}$). Again 0°C does not indicate complete absence of heat, rather it is the freezing point of water. Intelligent Quotient zero does not indicate complete absence of IQ, but indicates a serious intellectual problem.

RATIO SCALE

This scale has same properties as an interval scale; but because it has an absolute zero, meaningful ratios do exist in this scale. Weight in grams or pounds, time in seconds or days, BP in mm of Hg and pulse rate are all ratio scale data. Only temperature scale that follows interval scale is Kelvin scale. Zero pulse rate indicates an absolute lack of pulse. Therefore, it is correct to say that a pulse rate of 120 is twice as fast as pulse rate of 60.

Presentation of Statistics

After the data has been collected, it has to be sorted out and presented properly for analysis and interpretation. Presentation of data is an important stage in statistical study. Intelligent presentation makes the data more comprehensible. It aids the reader in quick understanding of complicated data. There are two main methods of presentation: Tabulation and Drawing.

Tabulation

Three types of tables are in use:

MASTER TABLE

In this table all initial readings as per the designed proforma are serially recorded. When the number of observations is large and several attributes have to be studied, the master table is a must. For example, postgraduate medical students have to prepare a master table or master chart for presentation of their thesis data.

SIMPLE TABLE

In this the characteristic under observation is fixed and the number or frequency of events is small.

FREQUENCY DISTRIBUTION TABLE

This is the most important table in statistical work. In a frequency table large, unsorted data is presented in a small manageable number of groups. It records how frequently a characteristic occurs in persons of the same group. In qualitative data, the characteristic remains the same and frequency varies, while in quantitative data, both are variable. Frequency tables can be prepared using either type of data.

Frequency Table of Qualitative Data

Here the characteristic, i.e. positivity for malarial parasite, is fixed but the frequency, i.e. the number of positives, varies. An example is given in **Table 23.1**.

Frequency Distribution Table of Quantitative Data

An example would be a table for height of 100 boys, varying from 160 to 180 cm, with a class interval of

TABLE 23.1: Blood smears examined for malarial parasite⁶

Phase	1969			1970		
	No. examined (in millions)	No. positives	%	No. examined (in millions)	No. positives	%
Attack	13.94	299810	2.15	11.93	421682	3.53
Consolidation	12.72	28829	0.23	8.64	24255	0.28
Maintenance	15.18	20008	0.13	13.64	26549	0.19
Total	41.84	348647	0.83	34.21	472486	1.36

2 cm (**Table 23.2**). In this the characteristic, i.e. height, is variable while the frequency of boys in each height group also varies. The number of boys in a particular range is recorded against each height category. The categories showing the range of the variable should preferably avoid fractions, so as to simplify calculation.

The following three points should be kept in mind while making such a table:

1. The class interval must be same throughout and the number of groups should not be unduly large.
2. The headings should be clear.
3. If the data are expressed in rates or proportions, this should be specified. If some data are omitted, the reason should be explained.

Drawings

The following drawings or diagrams are in common use:

HISTOGRAM

It is a graphic presentation of a frequency distribution (**Figs 23.1 and 23.2**). The character of different groups is indicated on the horizontal axis or abscissa, while frequency is indicated on the vertical axis or ordinate. The frequency of each group forms a column or rectangle. The heights of frequency rectangles vary and the area of a rectangle represents the frequency. Such a diagram is called histogram and is made use of in presenting quantitative data (such as of height in the frequency **Table 23.2**).

Frequency Polygon

It is simply a derivation from the histogram obtained by joining the midpoints of various histogram blocks. This is clear from (**Fig. 23.3**).

Frequency Curve

When the number of observations is large, the polygon loses angulations and it becomes a frequency curve (**Fig. 23.4**).

TABLE 23.2: Frequency table of height

Height of groups (in cm)	Markings	Frequency
160 – 162		4
162 – 164		8
164 – 166		10
166 – 168		12
168 – 170		16
170 – 172		15
172 – 174		12
174 – 176		10
176 – 178		8
178 – 180		5
Total		100

The frequency polygon and curve are drawn for presenting quantitative and continuous data.

Line Chart or Graph

It shows the trend of an event over a period of time. The trend may indicate rise, fall or fluctuations in occurrence of the event. Examples are graphs showing incidence of cancer, infant mortality, births, deaths, etc. (**Fig. 23.5**) shows the trend of population in India.

Bar Diagram

The length of the bar indicates the frequency, which is usually marked on the vertical line. The characteristic is shown on the base line. Such a diagram presents the

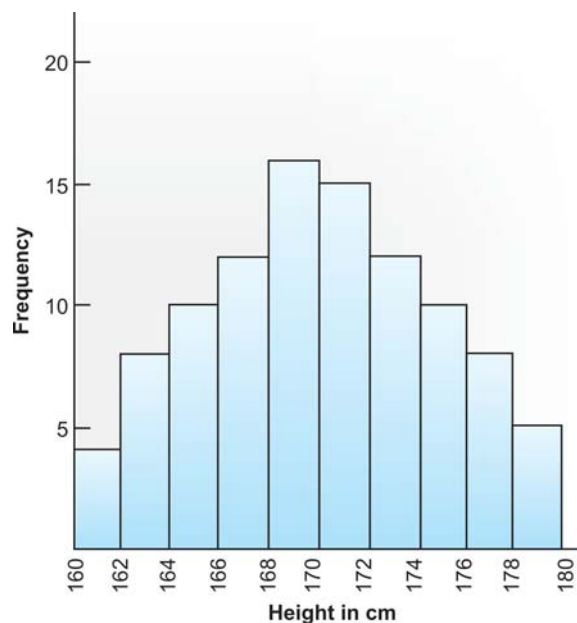


Fig. 23.1: Histogram of height of 100 boys

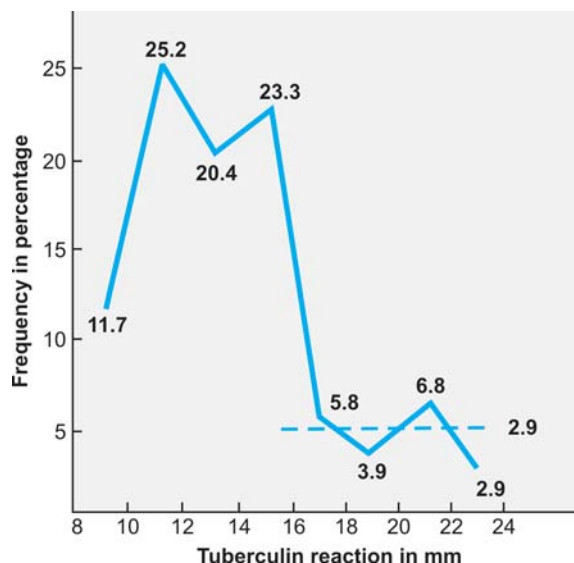


Fig. 23.2: Histogram showing tuberculin reaction in 206 persons, never vaccinated

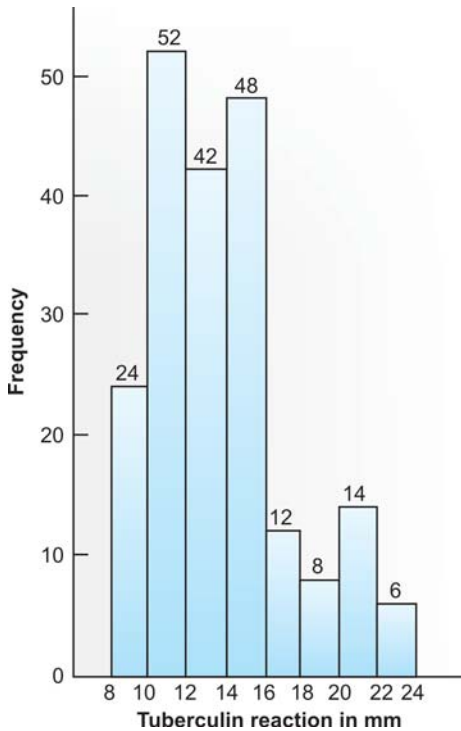


Fig. 23.3: Frequency polygon showing tuberculin reaction in 206 persons, never vaccinated

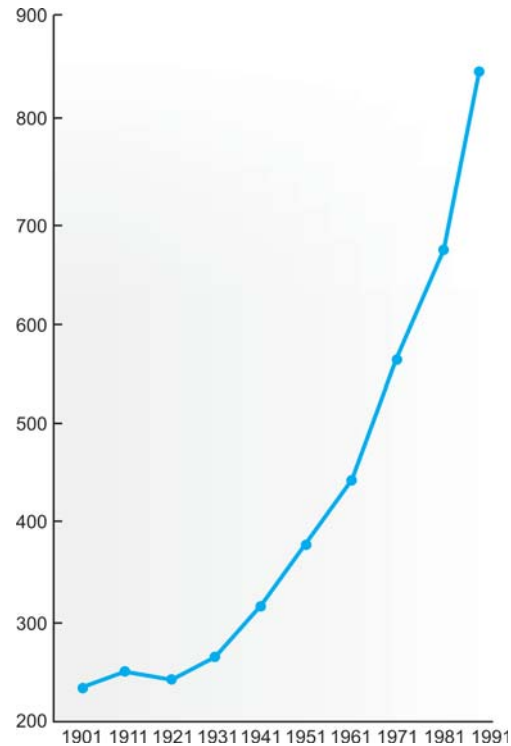


Fig. 23.5: Line chart showing the population trend in India

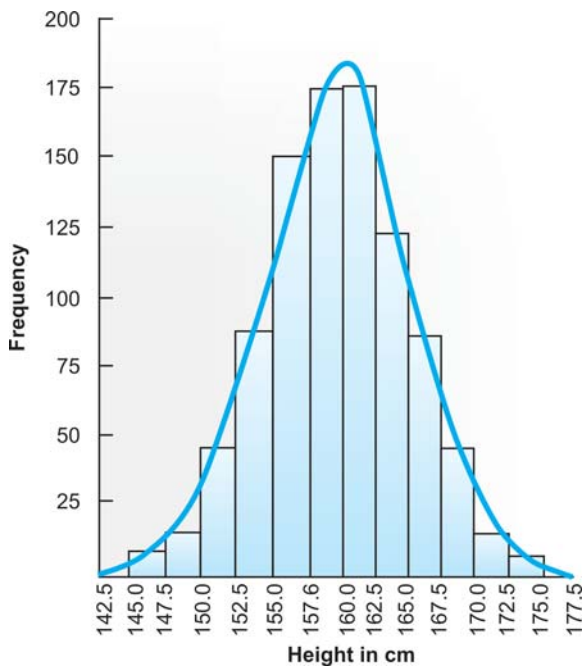


Fig. 23.4: Frequency curve of heights superimposed over histogram

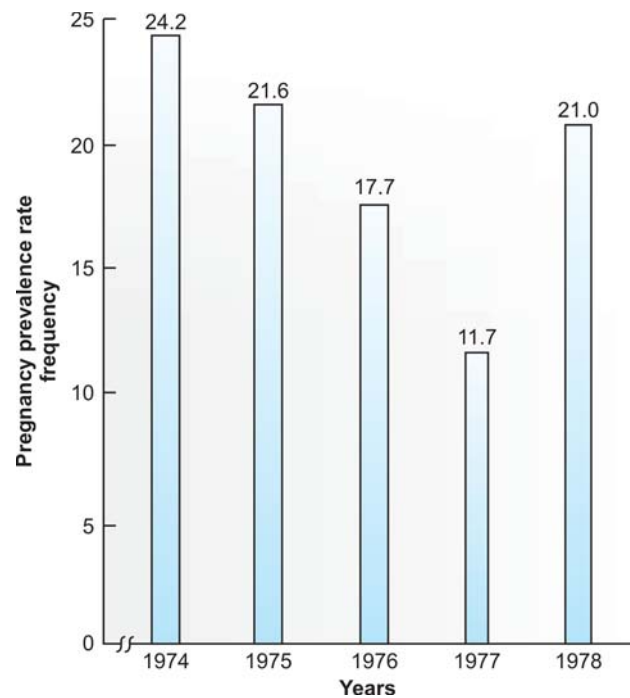


Fig. 23.6: Simple bar diagram showing yearly pregnancy prevalence rate per 1000 population, 1974-1978

relative values of a qualitative character in discrete data, such as morbidity in different sexes, professions or places. The bars may be drawn in ascending or descending order of magnitude as appropriate. The space between any two bars should be so adjusted that the presentation may appear neat, clean and easily comprehensible.

Figure 23.6 shows a simple bar diagram, while Figures 23.7 and 23.8 show multiple and proportional bar diagrams respectively.

SCATTER OR DOT DIAGRAM

A graphic presentation is made here to show the extent and nature of correlation between two variables such as height and weight, hence it is also called a 'correlation diagram'. Varying frequencies of the two characters in the same individual, or of one character in two different individuals (such as height of fathers and sons), give a number of meeting points or dots that show a scatter.

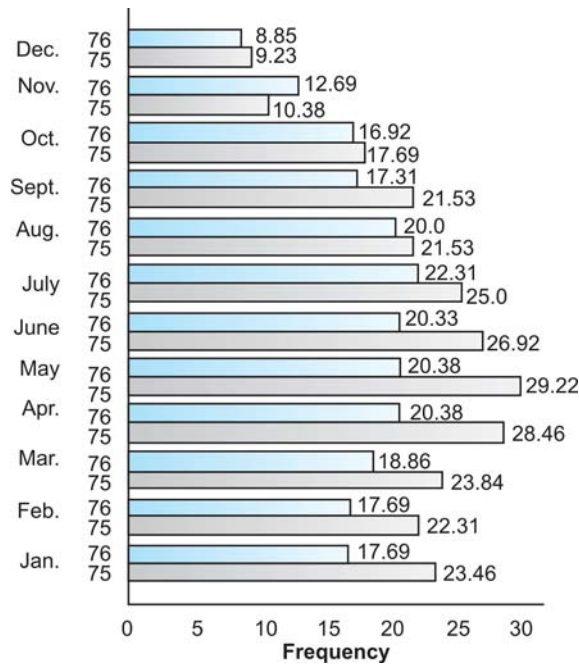


Fig. 23.7: Multiple bar diagram showing comparative pregnancy prevalence rate per thousand population by month in 1975 and 1976

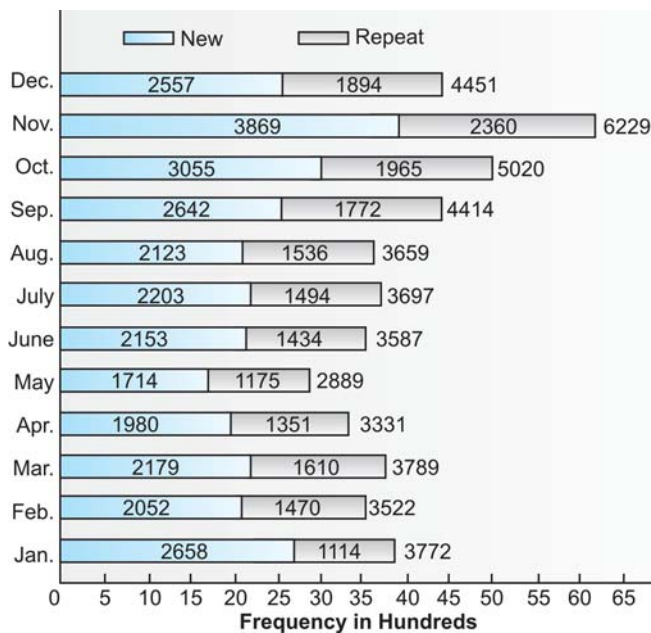


Fig. 23.8: Proportional bar diagram showing new and repeat outdoor attendance

A line is drawn to show the nature and extent of correlation at a glance (Fig. 23.9).

PIE OR SECTOR DIAGRAM

In this the data are presented in a circle. Degrees of angles and the area of the sectors denote the relative frequency of a character (Fig. 23.10).

MAP DIAGRAM OR SPOT MAP

These maps are prepared to show geographical distribution of the frequencies of a characteristic. A dot or a point indicates a unit of occurrence. For example,

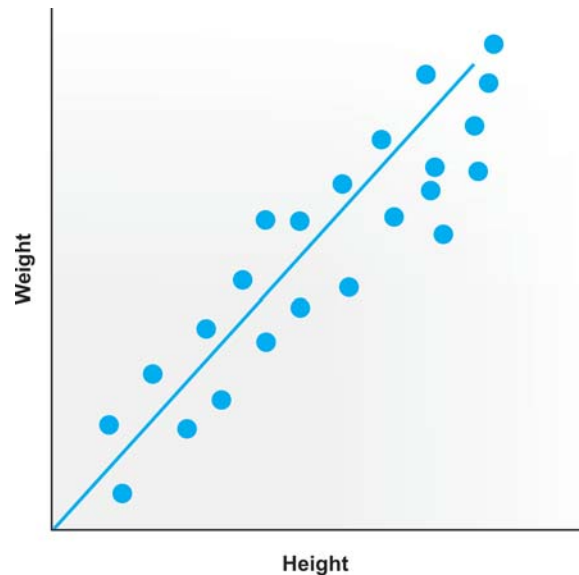


Fig. 23.9: Scatter diagram showing positive correlation

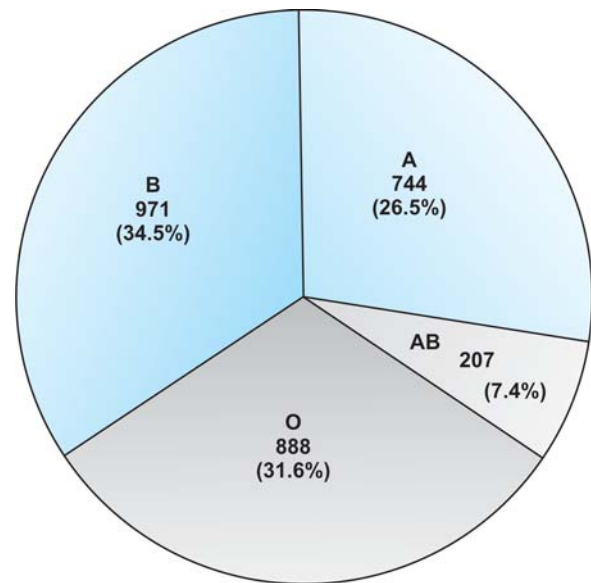


Fig. 23.10: Pie or sector diagram showing distribution of blood groups in Kolkata¹

one dot may mean 10 attacks or 10 deaths. Fractions are to be ignored. Two dots of two different colors on the map of a country may show two different characteristics, such as attacks and deaths, in different areas. The relative frequency of a disease may also be indicated by different marks such as O, X, + and -, etc. The spot map also helps in locating or pinpointing the index case in an epidemic. If the map shows 'clustering' of cases, it may suggest a common source of infection or a common environmental factor shared by all the cases.

Variability and Error

Variability

It is natural for biological characteristics to vary within certain limits. Common examples are height, weight, pulse rate, blood pressure, etc. This is called *Biological Variability*. It may be of three types:

Individual variability: For example, difference in the height of individuals

Periodic variability: For example, difference in the pulse rate or blood pressure of a person at different times

Group variability: For example, difference in height of males and females.

Biological variability is a fact of life and nothing can be done about it.

Errors

On the other hand, errors are induced in the data because of factors that can be controlled. Errors are again of three types:

Observer error: This may be subjective or objective. An example of subjective error is the faulty interrogation of individuals by an untrained investigator who keeps on varying the method of asking questions, tries to suggest answers to them or asks embarrassing questions which the respondents may hesitate to answer properly. An example of objective error is the faulty recording of blood pressure by measuring the same without proper positioning of the patient and without following a predetermined standard procedure for recording diastolic pressure. For example, it is preferable to note blood pressure at the 5th phase (i.e. total disappearance of sounds) rather than the muffling or fourth phase.⁷

Instrumental error: Common examples are a faulty weighing machine and a blood pressure cuff of inappropriate size. It may be mentioned that roughly speaking, the width of the sphygmomanometer cuff should be about half the arm circumference.⁷

Sampling error: A sample must be representative of the whole population. A biased, nonrandom sample or too small a sample cannot give reliable information about the total population. A common example of sampling error is drawing a sample from the hospital patient population and then trying to extrapolate the findings to the general population in the community. As contrasted to sampling error, the first two types, i.e. observer error and instrumental error, are called nonsampling errors.

At this point, it would be appropriate to clarify the terms accuracy and precision, though the two are often used interchangeably in ordinary English. Strictly speaking, the accuracy of a measurement depends on how closely the answer resembles the true answer while precision relates to the reproducibility with which a measurement can be made.⁸ Thus it is possible for a measurement to do very precise, yet not accurate. For example, 5 observers may weigh a man weighing 75 kg on a badly calibrated scale and obtain values of 70.0, 70.1, 70.2, 69.8, 69.9 kg. All these values are highly precise but far from being accurate, the difference between real and measured mean being 5 kg. On the other hand, another set of 5 observers may be asked

to guess the weight of a man weighing 75 kg. Their guesses might be 65, 70, 75, 80 and 85 kg. Here the mean is 75 kg, and the method is accurate yet the precision is poor. Thus, ideally, a method of measurement must be both precise as well as accurate.

Analysis and Interpretation of Data

Measures of Central Tendency

Two questions arise after data are collected and presented:

- What is the average or central value of the series?
- How are the other values scattered around the central value?

The central value or trend of a series of ranked measurements can be denoted in three ways—mean, mode and median. The term average usually pertains to the arithmetic mean.

Mean: This is the arithmetic mean which is the sum of measurements in a series divided by the number of measurements. For example, if the areas of five wheals produced by pricking the left arm of five individuals are 2, 6, 3, 4, 0 sq mm, the mean would be $15 \div 5 = 3$.

Median: It is the middle value of the series arranged in ascending or descending order. When the number of observations in the series is odd, as in the series of wheal sizes 0,2,3,4 and 6 mm arranged in ascending order, the middle value of 3 mm denotes the median. If the number is even, e.g. the ages of ten students, the median is calculated as follows:

Values in ascending order: 18, 18, 18, 18, 19, 20, 20, 21, 22, 22 years.

$$\text{Median} = \text{The mean of the mid pair} = \frac{19 + 20}{2} = 19.5 \text{ years}$$

Mode: It is the measurement which occurs most frequently in a series.

In the age series above, the mode is 18 years as it occurs most often (four times out of ten). Though mean is the most commonly used parameter, mode or median may be used in special cases. If a stray value, too large or too small than the rest, is likely to offset the mean in one or the other direction, the use of median is more helpful. An example would be the duration of illness of a disease. Mode may be useful in measuring the incubation period of a disease.

Measures of Dispersion

Two main measures in use are range and standard deviation. A related measure is coefficient of variation. The majority of health statistics is based upon the assumption that data are normally distributed, i.e. they follows a normal curve.

RANGE

Strictly speaking, it is the difference between the maximum and minimum measurements in the series. However, it is usual to denote range by expressing these two values themselves. In the series 3, 1, 6, 10 the range is $10 - 1 = 9$. It is the same thing as saying that the range is 1–10. The range is not a satisfactory measure because it ignores the distribution of all other observations within the extremes.

Standard Deviation (SD)

If we sum up the positive and negative deviations of the observations from the mean and calculate the average of these deviations, their sum and average will always be zero. In order to overcome this difficulty, if plus and minus signs are ignored and the absolute values of the deviations are considered, the average deviation thus found is called mean absolute deviation (MAD). It is not valid mathematically, hence it is not used. In statistical work, the measure of dispersion found most useful is the standard deviation. It is calculated as follows:

- All deviations from the mean are squared to overcome the difficulty of positive or negative sign;
- Squared values are summed up to find the sum of squares;
- Average squared deviation is worked out by dividing the sum of squares by the number of observations; this is known as variance;
- Finally the square root of this variance gives the standard deviation (SD) which is denoted as a σ (sigma).

$$\text{SD or } \sigma = \sqrt{\frac{\sum(\bar{x} - x)^2}{n - 1}} \quad \text{formula (a)}$$

Summing up the above steps:

Where S denotes the sum of series of readings, \bar{x} is the mean and n is the number of observations. It is seen in the formula (a) that the sum of squares has been divided by $(n - 1)$ in place of n . This is so because if we use n as the divider we get the variance and standard deviation of the universe or the population, while if we divide by $(n - 1)$, we get the sample variance or standard deviation. In medical statistics we are almost always concerned with the sample standard deviation. In a statistical sense, the term universe or population refers to all the different individual values, measurements or persons, etc. that may potentially exist. A sample is drawn from such a population or universe. Thus 100 guinea pigs used in an experiment constitute a sample, while the universe or population of guinea pigs consists of all the guinea pigs of that particular type in the world.

$$\text{SD} = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n - 1}} \quad \text{formula (b)}$$

SD can also be calculated by a simpler formula (b).

Example 1. Find the SD of incubation period of a disease in case of 5 patients, the individual values being 14, 10, 12, 11 and 13 days (**Table 23.3**).

USES OF STANDARD DEVIATION

- Summarizes the variation within a large distribution in the form of a single quantitative value and defines the normal limits of variation.
- Indicates whether the difference of an observation from the mean is real or by chance.
- Quantifies the probability of occurrence of a specified value in the sample or the population. (This is done by measuring the difference between the specified value and the mean in terms of the standard deviation and reading the probability from appropriate tables already available).
- Helps in finding the standard error which determines whether the difference between two means of similar samples is real or by chance.
- Helps in finding a suitable sample size for reaching valid conclusions.

COEFFICIENT OF VARIATION (CV)

It is the ratio of the standard deviation to the mean (expressed as a percentage), and is used to compare the relative dispersion in two series of dissimilar measurements. This coefficient may be used to compare variability of one character in two groups such as height in boys and girls, or of two characters in the same group such as blood pressure and height in boys only.

TABLE 23.3: Standard deviation of incubation period of a disease

Incubation period	Deviation from mean $\bar{x} = 12$	Squares of deviations
x	$\bar{x} - x = x$	$(\bar{x} - x)^2 = x^2$
14	2	4
10	-2	4
12	0	0
11	-1	1
13	1	1
60	0	10

Using formula (a),

$$\begin{aligned} \text{SD} &= \sqrt{\frac{\sum(\bar{x} - x)^2}{n - 1}} = \sqrt{\frac{10}{4}} \\ &= \sqrt{2.5} = 1.58 \end{aligned}$$

Using formula (b),

$$\begin{aligned} \text{SD} &= \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n - 1}} = \sqrt{\frac{730 - 3600/5}{5 - 1}} \\ &= \sqrt{\frac{10}{4}} = \sqrt{2.5} = 1.58 \end{aligned}$$

Example 2. Compare the variability of systolic blood pressure in children of age group 5 to 10 with that of age group 30 to 40. Their mean and SD were 100 and 8 in children and 120 and 12 in adults.

$$\text{CV in children} = \frac{8}{100} \times 100 = 8$$

$$\text{CV in adults} = \frac{12}{120} \times 100 = 10$$

Thus, variability of blood pressure is found to be more in adults.

Normal Distribution or Gaussian Distribution

It is the name given to a particular distribution of frequencies of measurements or observations of a biological character around the mean. It is called 'normal' because it is the usual distribution of frequencies in nature when the number of observations is pretty large and the group interval is small. The characteristics of such a distribution are as follows:

- Half the measurements lie above and half below the mean.
- Most of the measurements are concentrated around the mean. They become fewer and fewer towards the extremes and are symmetrically distributed on each side of the mean.
- In terms of standard deviation (SD) the limits mean ± 3 times the SD include 99 percent of all values. Mean \pm twice the SD include 95 percent of all values while mean \pm one SD include 68 percent of all values.

Table 23.3 roughly presents such a distribution.

NORMAL CURVE

A normal distribution presented graphically gives a smooth curve (**Fig. 23.11**) provided the number of observations are very large and the class interval is very small. It is more or less bell shaped but may be skewed slightly to the right or left in some cases. The mean, median and mode coincide. A perpendicular drawn on the curve from the mean divides the area under the curve into two equal halves. The area between the perpendiculars drawn from mean \pm 1SD forms 68 percent of the total area (34% on each side, because the curve is symmetrical). Similarly, the perpendiculars drawn from ± 2 SD and ± 3 SD cover 95 percent and 99 percent of the area, or observations, respectively.

The properties of normal distribution and a normal curve form the basis of many of the statistical tests. Values larger and smaller than mean ± 3 SD will be rare (less than 1%) in nature and those larger and smaller than mean ± 2 SD will occur less than 5 times in 100. In other words, chances of such values in a normally distributed

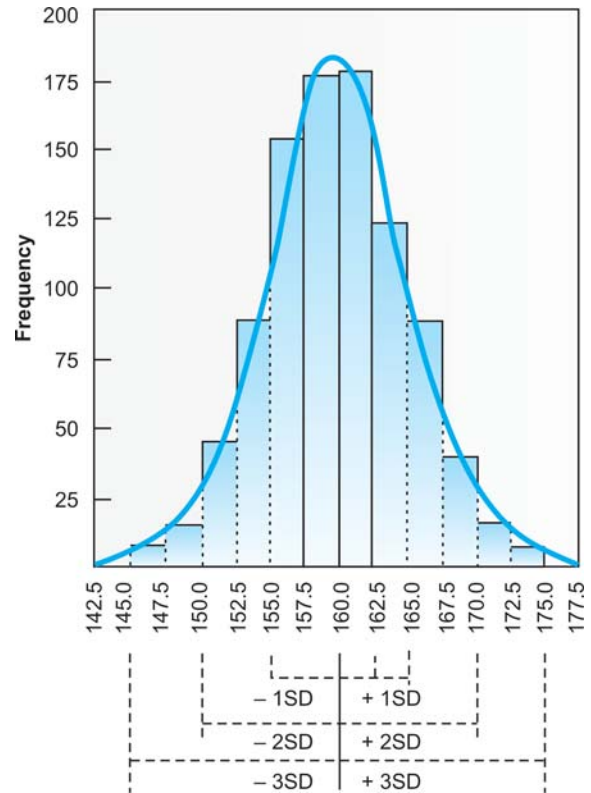


Fig. 23.11: Normal curve

set of data will be less than 1 percent and 5 percent respectively. Thus if mean systolic blood pressure in a large sample of normal men is 120 with SD of 10, the chance of finding a systolic pressure value of 155 (more than $120 + 3 \times 10$) in normal man is less than 1 percent. One can hence conclude that there is more than 99 percent chance that it is due to hypertension.

$$Z = \frac{\bar{x} - x}{SD}$$

We can find by the formula below, what percentage of values will be higher or lower than a particular observation if the mean and SD of a series are known.

The value obtained may be referred to in the table of unit normal distribution (**Appendix 23.1**).

Centiles and quartiles are also used to group the data. For example, when the observations are arranged in descending order, 10 percent observations lie below and 90 percent above the 10th centile. Similarly, quartiles divide the range into 4 divisions. 25 percent observations lie below and 75 percent above the first quartile. It is obvious that the median corresponds with the 50th centile.

Sampling

Values such as mean, SD or proportion calculated from a sample are descriptive of a series. The conclusions drawn are often applied to the whole universe or population. Such generalization is valid

only if the observed series or sample is representative of the whole population. This is possible only if the sample is chosen at random and is fairly large. Thus the mean blood pressure of 30 men would be representative only if the 30 men are typical of all men. If the 30 men are all senior executives, it would be a biased sample of all men but may be representative of senior executives.

It is not possible for any scientific study to cover the whole population. Moreover, it would be a waste of time, money and materials if we could reliably draw the same conclusions from a smaller representative sample.

Characteristics of a Random or Representative Sample

- It is selected by a proper sampling technique from the universe or population it represents.
- It differs from the universe in composition solely by chance.
- Each member of the universe from which it is taken has equal opportunity of being selected.
- All selection or bias has been ruled out and the sample mean is very close to the population mean.

Methods of Selecting a Random Sample

- *Simple random sampling*: The principle in this method is that every unit of population has an equal chance of being chosen (e.g. pulling out 10 cards one by one from a pack of 100 cards, numbered from 1 to 100, restoring the drawn card to the pack and shuffling it each time). Random sampling can be easily done by using the tables of random numbers.
- *Systematic sampling*: In this method, the sample is selected according to a predetermined periodicity out of the total number in the series. For example, every alternate, 5th or 10th house may be chosen for study, e.g. 6th, 16th, 26th and so on.
- *Stratified sampling*: In this method the sample is taken from each of the predefined strata of society, the basis for status stratification being age, sex, class, socioeconomic status, etc. Sampling is done randomly from each stratum and the number sampled is proportionate to the size of different strata.
- *Multistage sampling*: As the name implies, this method refers to the sampling procedures carried out in several stages using random sampling techniques. This method introduces flexibility in sampling, a feature lacking in other techniques. It also enables the use of existing divisions and subdivisions and thus saves the extra labor involved in independent enumeration or census. This method is employed in large country surveys. In the first stage, random numbers are used to sample the districts in the state, followed successively by random sampling of taluks, villages and houses.

Sampling Variations

So far we have dealt with variations of the individual readings from the mean in terms of standard deviation. Now we may study the variation in sample estimates of means, proportions, and standard deviations from one sample to another, or between a sample and the universe.

Sampling Distribution

A mean (m) or a proportion (p) derived from a sample will vary from the universal mean (M) or proportion (P) by chance. If two or more samples are drawn from the same universe, their means (m_1, m_2, m_3, \dots) may not be equal but will show variation. The variation from the universal mean is known as 'Inherent, Sampling Variation'. If a large number of such samples are drawn from the universe, their means will show a frequency distribution which conforms to the normal curve. The mean of the sample means will approximate the population or universe mean (M), while the means of the samples show dispersion around the population mean with a definite standard deviation. This standard deviation is called the standard error of the mean, (denoted as $SE \bar{x}$ or, simply, as the standard error (SE).

Confidence Limits

Sample means are normally distributed about their population mean. If the observed estimate lies in the region population means $\pm 2 SE$, then, conversely, the population mean will lie within the limits sample means $\pm 2 SE$. Since approximately 95 percent of all sample means lie in the region population mean ± 2 standard errors, the chance that the population mean lies between the limits defined by sample mean $\pm 2 SE$ is also 95 percent. The 95 percent confidence limits are, therefore, the sample estimate ± 2 standard errors approximately. The confidence of the limits is increased by increasing the number of standard errors, e.g. the 99 percent confidence limits are approximately defined by the sample estimate ± 3 standard errors.

Standard Error

If the average number of attacks of diarrhea per child per year is 4 in a particular area, we will not necessarily get an average of 4 if we take a sample of children in another area, where it may be only two per child. In a third area, on the other hand, the average may be 6 or more. These variations in the means are inherent in any sampling. If we take a very large sample with children from the three areas included almost equally, the average attacks per child will be more or less 4 per year. Thus variation can be reduced by increasing the sample size. On the other hand, if the variation in means

is large (such as 10 attacks in one example and 30 and 40 in others), the standard error will be increased. The standard error thus depends upon two factors:

1. Standard deviation of the sample, which measures the variability of the observations.
2. Size of the sample.

Standard error can be calculated by the formula:

$$SE = \frac{SD}{\sqrt{n}}$$

It can be seen from the formula that SE varies inversely with the root of the sample size.

Tests of Significance

It is natural for sample estimates (means or proportions) to vary from sample to sample. This natural variation is called chance variation. The variation from sample to sample or between a sample and the universe could also be due to some external factor. A medical researcher very often needs to compare certain measurements in experimental and control groups. It is necessary to rule out the possibility of a chance difference when the values for the two groups are compared. The tests of significance are statistical tests or mathematical methods which measure the probability of chance occurrence of such difference in nature. For example, suppose the mean weight gain in 100 children receiving a nutritional supplement was 2 kg after 9 months (increase from mean weight of 15 to 17) while the gain in the control group was 1 kg (increase from mean weight of 15 to 16). Whether this difference of 1 kg in weight gain is a chance occurrence of no significance or whether it is attributable to supplementary feeding has to be decided to establish the value of the latter.

A test of significance will measure the probability of increase in weight by chance. If the probability of occurrence of such a difference is less than 5 times out of 100, it is said to be significant or statistically significant, i.e. $p < 0.05$. In that case, the difference will be due to the nutritional supplement in more than 95 percent of such experiments. The sample estimate is then said to be significant or significantly different at 5 percent level of significance. This difference could be by chance only once in twenty trials. The difference is highly significant if the probability of chance occurrence is less than 1 percent ($p < 0.01$).

Null Hypothesis

This is an assumption according to which the observed difference between the specified population value and the sample estimate is due solely to sampling variation, i.e. due to chance. Using the null hypothesis, it is assumed that the variable under study, e.g. a drug, has no effect and that the results observed are similar in the experimental and control groups. If the difference is found to be more than twice the standard error, so that the probability of chance occurrence is less than 5 times

in 100 experiments, the null hypothesis of no difference is rejected and the factor under trial is considered to have definitive action. If the probability is more than 5 percent, the null hypothesis is accepted.

The following tests of significance measure the probability or chance of occurrence of biological variation in sample estimates.

Standard Error of the Mean

It measures the chance difference of a simple mean (m) in comparison to the population mean (M). The test defines the confidence limits of the population value. We can also know whether a particular sample is drawn from a particular universe or not, if the mean of that universe, i.e. the population mean, is known.

Example 3. Mean and SD for the heights of 50 boys are 150 and 7 cm respectively. Find the SE of mean and the 95 percent confidence limits. Is there a significant possibility (at the 5% level) that this sample is drawn from a universe with a population mean of 154 cm?

$$\text{Mean} = 150 \text{ cm}$$

$$\text{SD} = 7 \text{ cm}$$

$$SE \bar{x} = \frac{SD}{\sqrt{n}} = 0.98$$

95 percent confidence limits in nature will be:

$$\text{Mean height} \pm 2 SE = 150 \pm 2 \times 0.98 = 151.96 \text{ and } 148.04$$

$$\frac{M - m}{SE X} = \frac{154 - 150}{0.98} = \frac{4}{0.98} = 4.08$$

(more than 4 times SE)

Obviously, the sample of 50 boys is not drawn from the universe with a mean of 154 cm because, the latter is much higher than the upper 95 percent confidence limit of 151.96 and is more than 4 SE away from the sample mean. In order to test the probability that the sample mean 150 could come from a universe with population mean 154, let us find the difference between these two means in terms of the standard error.

It can be seen from Appendix I that the possibility of a value beyond + 3 SE is 0.0013 or 0.13 percent. The possibility of a value beyond + 4 SE is, in fact, 0.0003 or 0.03 percent. The specified value of 154 cm in the present example is placed at + 4.08 SE and would be slightly less than 0.03 percent. (It may be mentioned that a value of mean + 1 SD refers to a value 1 SD away to the right, while a value of mean - 1 SD refers to a value 1 SD away towards the left).

Standard Error of the Difference between Two Means

This measures the likelihood of chance difference between two samples means. If the observed difference ($m_1 - m_2$) is more than twice the SE of difference between means, it is significant at 95 percent confidence limits.

APPENDIX 23.1: Table of unit normal distribution (UND), single-tail

The table to find the percentage of area or observations in the normal distribution which lie beyond various standard deviation

$$\text{units } \left(Z = \frac{\bar{X} - X}{SD} \right) \text{ from the mean. } Z \text{ is } 0 \text{ at the mean.}$$

Z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3662	0.3594	0.3557	0.3520	0.3483
0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
0.7	0.2420	0.2389	0.2358	0.2327	0.2297	0.2266	0.2236	0.2206	0.2177	0.2148
0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
2.0	0.0228	0.0222	0.2197	0.0212	0.0207	0.0207	0.0197	0.0192	0.0188	0.0183
2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0022	0.0119	0.0116	0.0113	0.0110
2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0929	0.0028	0.0027	0.0026
2.8	3.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0012	0.0011	0.0011	0.0010	0.0010

Vertical column headed Z gives the Z values up to one decimal point such as 0.1, 0.2, etc. while horizontal values to the right of Z give the Z values up to two decimal points such as 0.00, 0.01, 0.02, etc.

To know the area or percentage of observation lying beyond the Z value of 1.96, find 1.9 in the Z column at the extreme left and then read across to the column headed 0.06. The area is 0.025 and hence the percentage of observations will be 2.5%.

Single-tail means the area or observations lying to only one side of the curve mean beyond a defined point.

When Z is +1.5, the area of the curve beyond or the percentage of observation above the value corresponding to Z = 1.5 will be 0.0668 or 6.68%. Similarly, when Z is -1.5 the proportion of observations below the value corresponding to Z will be 6.68%.

Example: If the mean height \bar{X} is 160 cm with SD of 5 cm, calculate the Z value for an observation X 172.9 cm and interpret the result in the light of UND.

$$Z = \frac{172.9 - 160}{5} = 2.58$$

The table value for Z = 2.58 is 0.0049. It means only 0.49% observations will exceed height 172.9 cm if heights are normally distributed.

$$\text{Conversely, if the observed } X \text{ is } 147.1 \text{ cm, then } Z = \frac{147.1 - 160}{5} = -2.58$$

The table value for Z = 2.58 is 0.0049. It means only 0.49% observations will be less than height 147.1 cm.

The probability values corresponding to, different Z values (both tails, i.e. probability of an observation being higher or lower than the mean) are given below:

Z:	1.645	1.960	2.326	2.576	3.291
P:	0.10	0.05	0.02	0.01	0.001

Mathematically, it is the root of the sum of the squares of the two SEs for the two sample means.

The SE of difference between means is:

Example 4: In a study on growth of children, one group of 50 children had mean height 59 cm and SD

$$\begin{aligned}\sqrt{\{SE_1\}^2 + \{SE_2\}^2} &= \sqrt{\frac{(S_1)^2}{\sqrt{n_1}} + \frac{(S_2)^2}{\sqrt{n_2}}} \\ &= \sqrt{\frac{s_1^2}{n_1} \times \frac{s_2^2}{n_2}}\end{aligned}$$

2.4 cm while another group of 75 children had mean height 61 cm and SD of 3.1 cm. Is the difference between the two means statistically significant?

The difference between the two means in terms

$$\begin{aligned}&= \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \\ &= \sqrt{\frac{(2.4)^2}{50} + \frac{(3.1)^2}{75}} \\ &= \sqrt{0.2533} = 0.51\end{aligned}$$

$$\text{of SE} = \frac{61 - 59}{0.51} = \frac{2}{0.51} = 3.92$$

The observed difference is more than 3 times the SE, hence it is highly significant. The area of the normal curve beyond + 3.92 SD is 0.00005. Hence this implies that there is a probability of only 0.00005 or 0.005 percent that the difference of 2 cm between the two sample means could be by chance if they were drawn from the same universe. In other words, there is only a 0.005 percent probability that the two groups of children belong to the same universe. More simply, it might be stated that the difference between the two sample means is real and that growth is significantly more in the second group than in the first ($p = 0.00005$).

't' Test

The two tests described above are applicable only to large samples. WS Gossett observed that the normal distribution gives biased results in case of small samples. He demonstrated that the ratio of the observed difference between 'two values to the SE of difference follows a distribution called 't' distribution and such a ratio is denoted as 't'.

Applications: The 't' test is an accurate method to test the significance of difference between two means or proportions in small samples. The table giving the probability of observing a higher 't' value by chance with particular degrees of freedom, is known as 't' table. It is available in any standard book on statistics and is given in **Appendix 23.2**. The 't' value is read from the table against the known degrees of freedom (df). The tabulated 't' value at the chosen level of significance is to be compared with the 't' value calculated as follows:

For unpaired sample

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\text{SE of difference between means}}$$

For paired samples

$$t = \frac{\bar{d}}{\text{SE of } d}$$

Where

d = difference in the two values for each pair (total number of pairs being n).

\bar{d} = mean of the n values for d.

It may be remembered here that SE of d = $\frac{\text{SD of } d}{\sqrt{n}}$

In paired series, the two sets of observations are made on the same individuals and the difference is compared before and after exposure to some factor such as a drug. In unpaired series, the observations are made on two different groups of individuals and the difference between the two groups is compared.

In case of unpaired series, degrees of freedom $df = n_1 + n_2 - 2$ while in paired series, $df = n - 1$. If the estimated or calculated 't' value is higher than the tabulated 't' value, the difference is statistically significant; if it is less, the difference is insignificant.

Standard Error of Proportions

Information is not always quantitative and all data cannot be expressed as measured values. If a quality, attribute or character of a series of persons is described as vaccinated or unvaccinated, alive or dead, etc. such data, being qualitative in nature, is presented simply as the number counted to be positive or negative for the attribute. For example, out of 100 persons whose blood groups were typed, 10 were negative. This type of data is expressed as a proportion by saying that the proportion of Rh negativity in the sample is 10/100 or 0.1.

If a sample is divided into two classes only such as successes and failures, vaccinated and not vaccinated, polymorphs and nonpolymorphs, etc. it is called a binomial sample having binomial classification (binomial means divided into two classes.). If the sample is divided into more than two classes such as blood groups A, B, O and AB or WBC types polymorphs, lymphocytes, eosinophils, etc. the sample is called multinomial.

APPENDIX 23.2: Table of 't'
Probability of larger value of 't'

DF	0.10	0.05	0.02	0.01	0.001
1.	6.31	12.71	3.82	63.66	636.62
2.	2.92	4.30	6.97	9.93	31.60
3.	2.35	3.18	4.54	5.84	12.92
4.	2.13	2.78	3.75	4.60	8.61
5.	2.02	2.57	3.37	4.03	6.87
6.	1.94	2.45	3.14	3.71	5.96
7.	1.90	2.37	3.00	3.50	5.41
8.	1.86	2.31	2.90	3.36	5.04
9.	1.83	2.26	2.82	3.25	4.78
10.	1.81	2.23	2.76	3.17	4.59
11.	1.80	2.20	2.72	3.11	4.44
12.	1.78	2.18	2.68	3.06	4.32
13.	1.77	2.16	2.65	3.01	4.22
14.	1.76	2.15	2.62	2.98	4.14
15.	1.75	2.13	2.60	2.95	4.07
16.	1.75	2.12	2.58	2.92	4.02
17.	1.74	2.11	2.57	2.90	3.97
18.	1.73	2.10	2.55	2.88	3.92
19.	1.73	2.09	2.54	2.86	3.88
20.	1.73	2.09	2.53	2.85	3.85
21.	1.72	2.08	2.52	2.83	3.82
22.	1.72	2.07	2.51	2.82	3.79
23.	1.71	2.07	2.50	2.81	3.77
24.	1.71	2.06	2.49	2.80	3.75
25.	1.71	2.06	2.49	2.79	3.73
26.	1.71	2.06	2.48	2.78	3.71
27.	1.70	2.05	2.47	2.77	3.69
28.	1.70	2.05	2.47	2.76	3.67
29.	1.70	2.05	2.46	2.76	3.66
30.	1.69	2.04	2.46	2.75	3.65
40.	1.68	2.02	2.42	2.70	3.55
60.	1.67	2.00	2.39	2.66	3.46
120.	1.66	1.98	2.36	2.62	8.37
∞	1.65	1.96	2.33	2.58	3.29

The table gives the probability of observing a higher 't' value by chance at particular degrees of freedom. The probability of observing a value off greater than 2.95 at 15 degrees of freedom is 0.01 or 1%.

The proportions of positive and negative attributes or classes in a binomial sample are expressed as:

$$p = \frac{r}{n} = \frac{\text{Number having a specific character}}{\text{Total number in the sample}}$$

p is the probability of occurrence of the positive attribute such as attacked, vaccinated, etc. and q (= 1 - p) is the probability of non-occurrence of the same attribute such as not attacked, unvaccinated, etc.

The concept of standard error of proportion (SEP) and its derivation is similar to that of standard error of the mean. Sample proportions also follow normal distribution.

$$\text{SEP} = \sqrt{\frac{pq}{n}}$$

where p is the positive attribute

and q = 1 - p.

Example 5. 30 out of 100 persons in a sample had blood group A. Find the SEP and the 95 percent limits of confidence. Could this sample be from a universe in which the prevalence of blood group A is 40 percent ?
 $p = 0.3$ $q = 1 - 0.3 = 0.7$ $n = 100$

$$\text{SEP} = \sqrt{\frac{pq}{n}} = \sqrt{\frac{0.3 \times 0.7}{100}} = 0.0458$$

$$\begin{aligned} 95\% \text{ confidence limits} &= 0.3 + 2 \times 0.0458 \\ &\text{i.e. } 0.3916 \text{ and } 0.2084 \end{aligned}$$

Since the proportion 0.4 is outside the 95 percent confidence limits we can say with 95 percent confidence that the sample is not drawn from a universe having 40 percent prevalence of blood group A.

Standard Error of Difference between Two Proportions

This test measures the probability of chance occurrence of a particular difference between two sample proportions. If the observed difference between two proportions ($p_1 - p_2$) is more than twice the SE of difference, it is significant at 95 percent confidence level.

The appropriate formula for calculating the SE of difference between proportions is as follows:³

$$\text{SE of difference between proportions} = \sqrt{pq \left\{ \frac{1}{n_1} + \frac{1}{n_2} \right\}}$$

Where n_1 and n_2 represent the total number in each sample and

$$p = \frac{r_1 + r_2}{n_1 + n_2}$$

Once this formula is applied and the null hypothesis is rejected, then the formula for SE of difference between proportions for fixing the confidence limits is as follows:³

$$\text{SE of difference in proportions} = \sqrt{\frac{p_1q_1}{n_1} + \frac{p_2q_2}{n_2}}$$

However, both these methods give closely similar results. It is common to use only the second formula given above for both purposes since it is often more convenient, though not logical.²

Example 6. Suppose cholera mortality in one sample of 50 is 7 and in another sample of 50 it is 18. Find SE of difference between proportions. Is the difference in mortality rates significant?

$$\text{For sample 1, } p_1 = \frac{7}{50} = 0.14 \quad q_1 = 1 - 0.14 = 0.86$$

$$\text{For sample 2, } p_2 = 18 \div 50 = 0.36 \quad q_2 = 1 - 0.36 = 0.64$$

$$\begin{aligned} & \text{SE of difference between } p_1 \text{ and } p_2 \\ &= \sqrt{\frac{p_1 \times q_1}{n_1} + \frac{p_2 \times q_2}{n_2}} \\ &= \sqrt{\frac{0.14 \times 0.86}{50} + \frac{0.36 \times 0.64}{50}} \\ &= \sqrt{0.00241 + 0.00461} = \sqrt{0.00702} = 0.0838 \end{aligned}$$

It may be mentioned that using the formula

$$\sqrt{pq \left\{ \frac{1}{n_1} + \frac{1}{n_2} \right\}}$$

It may be mentioned that using the formula the SE of difference between proportions p_1 and p_2 is computed as 0.0866 which is close to 0.0838. The difference in mortality rates is more than twice the SE of difference, hence it is significant at 95 percent confidence level.

The above two tests related to proportions are applicable in case of large samples. For small samples, the Chi-square test is usually applied. However, the results of both tests are the same.

Chi-Square (χ^2) Test

χ is a Greek letter, written as chi and pronounced as Kye. χ^2 test was developed by Karl Pearson and is an important test of significance. It involves calculation of a quantity called χ^2 . This test is applied to rule out chance or to estimate the probability of chance occurrence of a difference as described below.

1. To find if the difference between two proportions is real or by chance as described above.

2. To find any association between two attributes occurring together such as cancer and smoking, age and blood pressure, parity of mother and weight of the newborn, etc. The test measures the probability of association by chance. According to null hypothesis the assumption of no association or independence is made. If the χ^2 value is higher than that given in the χ^2 table against a probability of 0.05, for the particular degrees of freedom, the association is not apparent but real, at 5 percent level of significance. Then null hypothesis is rejected and we conclude that the two attributes or events are dependent on each other.

The first requirement for the application of chi-square test is making a contingency table of the observed frequencies. Expected frequencies are calculated on the assumption of no association. If there are only two events and 2 groups or classes it is called a 2×2 or four-fold or four-cell contingency table. Often the groups are more, such as social classes I, II,

III and IV among smokers and nonsmokers.

The degrees of freedom (DF) are calculated from the number of columns (c) and rows (r) in a table by the formula: $DF = (c - 1)(r - 1)$

In a 2×2 table the degrees of freedom will be $(2 - 1) \times (2 - 1) = 1$.

Example 7: An experiment was carried out aimed at assessing the efficacy of neomycin in preventing staphylococcal cross-infection during first 14 days after burns. Infection developed in 18 of 30 patients whose burns were dressed with penicillin cream compared to 5 out of 33 patients in whom both penicillin and neomycin were used. What conclusion will you draw from this data?

First we prepare the contingency in **Table 23.4** as below:

In the four-cell contingency table above, the observed frequency O in the cells a, b, c, d is 5, 28, 18 and 12 respectively. The expected frequency E, assuming no association (i.e. no effect of neomycin) for each cell, is calculated by using the following formula:

$$E = \frac{\text{row total} \times \text{column total}}{\text{total no. in the sample}}$$

Thus E in cell (a) = $33 \times 23 \div 63 = 12.05$

The chi-square value for each cell is calculated

$$\text{by using the formula } \chi^2 = \frac{(O - E)^2}{E}$$

The total of chi-square for all the four cells is then calculated as follows:

$$\begin{aligned} \chi^2 &= \frac{\{O - E\}^2}{E} = \frac{\{5 - 12.05\}^2}{12.05} + \frac{\{28 - 20.95\}^2}{20.95} \\ &+ \frac{\{18 - 10.95\}^2}{10.95} + \frac{\{12 - 19.05\}^2}{19.05} \\ &= 4.1247 + 2.3724 + 4.5390 + 2.6090 = 13.6451 \end{aligned}$$

To find the significance of the calculated χ^2 value, we refer to the χ^2 table and find the tabulated χ^2 value corresponding to a given probability like 0.05 or 0.01 against the appropriate degrees of freedom. The tabulated value of chi square at probability 0.05 (5% level) and 0.01 (1% level), against 1 DF is 3.84 and

TABLE 23.4: An experiment showing the contingency of the application of antibiotics

Antibiotic applied	Staphylococcal infection acquired	Infection not acquired	Total
	(a)	(b)	
Penicillin cream plus neomycin	O 5.00 E 12.05	O 28.00 E 20.95	33
	(c)	(d)	
Penicillin cream alone	O 18.00 E 10.95	O 12.00 E 19.05	30
Total	23.00	40.00	63

6.64 respectively, while the calculated value is 13.64 in our example. It is much higher than the tabulated χ^2 value at both the levels, so the null hypothesis is rejected. The difference between the effect of two drugs combined and that of penicillin alone is significant and we conclude that addition of neomycin is more prophylactic against staphylococcal infections.

YATES' CORRECTION

When the expected frequency in any cell of the four-fold table is less than 5, Yates' correction, also known as correction for continuity, should be applied as shown below to obtain a more accurate value of chi square.

by using the formula
$$\chi^2 = \frac{\{[O - E] - \frac{1}{2}\}^2}{E}$$

In a four-fold table χ^2 value can also be obtained without or with Yates' correction by the following formulae:

WITHOUT YATES' CORRECTION

$$\chi^2 = \frac{\{ad - bc\}^2 \times n}{\{a + b\} \{c + d\} \{a + c\} \{b + d\}}$$

Where a, b, c and d are the observed frequencies of events in different cells and n is the sample total.

With Yates' Correction

$$\chi^2 = \frac{\{[ad - bc] - \frac{n}{2}\}^2 \times n}{\{a + b\} \{c + d\} \{a + c\} \{b + d\}}$$

It should be noted in the above formula that [ad-bc] refers to the absolute difference between ad and bc so that even if ad is 60 and bc is 504 in the table above, ad-bc will be considered as 444, and n/2 will have to be deducted from it for Yates' correction.

3. As a test of "goodness of fit" of observations to a hypothetical distribution. An assumption of no difference between the observed and hypothetical proportions is made and the χ^2 test is applied.

Example 8. The ratio of male to female births in nature is 1:1. If 52 male and 48 female children are born in a small town, could this difference be due to chance?

	Male	Female
Observed frequencies	52	48
Expected frequencies	50	50

$$\chi^2 = \frac{\{52 - 50\}^2}{50} + \frac{\{48 - 50\}^2}{50} = \frac{8}{50} = 0.06$$

(Interpretation: There are two classes, hence degrees of freedom = 2-1 =1. χ^2 with 1 degree of freedom at 5 percent level of significance = 3.841. The calculated value of χ^2 is much less and is hence insignificant. The observed difference in sexes is by chance).

It is very important to remember that the chi square test is applied to actual numbers and not to percentages. The reason would be clear from the following: Suppose the town referred to in the above example were a fairly big one so that 5200 male and 4800 female babies were born, the expected frequency in each case being 5000, assuming null hypothesis. Then:

$$\chi^2 = \frac{\{5200 - 5000\}^2}{5000} + \frac{\{4800 - 5000\}^2}{5000} = 16$$

This would be very highly significant. Now the unwary could have attempted to interpret the birth pattern in this big town by posing the following question for himself. If the birth rate in a town is 52 percent for males and 48 percent for females, is this difference significant? In that case he would have, ignoring the actual numbers and relying only upon the percentages, proceeded exactly as shown in the example above and calculated a chi square value of 0.16, which is clearly insignificant.

The table of chi square is given in **Appendix 23.3.**

APPENDIX 23.3: Table of χ^2 Probability (P)						
F	0.50	0.10	0.05	0.02	0.01	0.001
1.	0.46	2.71	3.84	5.41	6.64	10.83
2.	1.39	4.61	5.99	7.82	9.21	13.82
3.	2.37	6.25	7.82	9.84	11.34	16.27
4.	3.36	7.78	9.49	11.67	13.28	18.47
5.	4.35	9.24	11.07	13.39	15.09	20.52
6.	5.35	10.65	12.59	15.03	16.81	22.46
7.	6.35	12.02	14.07	16.62	18.48	24.32
8.	7.34	13.36	15.51	18.17	20.09	26.13
9.	8.34	14.68	16.92	19.68	21.67	27.88
10.	9.34	15.89	18.31	21.16	23.21	29.59
11.	10.34	17.28	19.68	22.62	24.73	31.26
12.	11.34	18.55	21.03	24.05	26.22	32.91
13.	12.34	19.81	22.36	25.47	27.69	34.53
14.	13.34	21.06	23.69	26.87	29.14	36.12
15.	14.34	22.31	24.99	28.20	30.58	37.70
16.	15.34	23.54	26.30	29.63	32.00	39.25
17.	16.34	24.77	27.59	30.99	33.41	40.79
18.	17.34	25.99	28.87	32.35	34.81	42.31
19.	18.34	27.20	30.14	33.69	36.19	43.82
20.	19.34	28.41	31.41	35.02	37.57	45.32
21.	20.34	29.62	32.67	36.34	38.93	46.80
22.	21.34	30.81	33.92	37.66	40.29	48.27
23.	22.34	32.01	35.17	38.97	41.64	49.73
24.	23.34	33.20	36.42	40.27	42.98	51.18
25.	24.34	34.38	37.65	41.57	44.31	52.62
26.	25.34	35.56	38.89	42.86	45.64	54.05
27.	26.34	36.74	40.11	44.14	46.96	55.48
28.	27.34	37.92	41.34	45.42	48.28	56.89
29.	28.34	39.09	42.56	46.69	49.59	58.30
30.	29.34	40.26	43.77	47.96	50.89	59.70

The table gives the highest values of χ^2 , at particular degrees of freedom, corresponding to probability P of occurrence by chance in nature. For example, at 10 degrees of freedom, χ^2 value larger than 18.31 will occur less than 5 times in 100 (P) and is interpreted as significant at 5% level.

Correlation Coefficient

It measures the degree of linear association or relationship between two characteristics in the same individuals such as height and weight, surface area and BMR, etc. Chi square test indicates only the presence or absence of association but it does not measure the degree of association. Coefficient of correlation is denoted by 'r' and the formula for calculating 'r' is:

$$r = \frac{\sum \{X - \bar{X}\} \{Y - \bar{Y}\}}{\sqrt{\sum \{X - \bar{X}\}^2 \{Y - \bar{Y}\}^2}}$$

Where X and Y are the two characteristics which are being measured.

The value of r lies between -1 and +1. If it is +1, it shows perfect positive correlation; a value of -1 shows perfect negative correlation. If it is 0, there is absolutely no correlation. Between 0 and +1 and 0 and -1, partial positive or partial negative correlations exist.

The significance of nonzero values of the coefficient is easily evaluated by referring to a correlation table, using the correct degrees of freedom (DF = n - 2, where n is the number of paired measurements).

Graphic presentation of the correlation coefficient of two attributes can be done by drawing a line through a scatter diagram representing the average position. This line is known as regression line. The method of preparing a scatter diagram has already been described. This line may be vertical, horizontal, diagonal or slanting in one or the other direction, depending on the type and degree of correlation.

Regression Coefficient

It is usually denoted by the letter b and it indicates the change (yc) in one variable (y) from its mean (y) for one unit of change in another variable (x) from its mean (x). It is used in regression equations to calculate the unknown value of Y when the value of X is known.

Regression coefficient (b) of X and Y can be calculated by the formula:

$$b_{yx} = \frac{\sum xy}{\sum x^2} \quad (\text{b of Y on X})$$

For detailed application of tests of significance, the student should refer to book on biostatistics as already suggested.¹⁻⁴

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Research is a systematic process aimed at obtaining new knowledge through verifiable examination of data and empirical testing of hypothesis. Research activities are directed towards finding answers, seeking solutions or looking for improved designs of functioning. Very often, no positive results emerge and a probable hypothesis may be negated. This in no way undermines the effort. In general, research activities in community medicine are more concerned with 'applied' aspects but basic research can also be undertaken.

As against research in many subjects which are undertaken on a philosophical or intellectual level, i.e. concerned with knowledge for its own sake, research in community medicine is warranted only for the purpose of gathering knowledge or information for improving the health of the community or for improving the service delivery network, i.e. operations research. This research should not be carried out just for the sake of collecting data. Medical sciences in general, and community medicine in particular, deal with human beings. Hence ethical considerations demand that research procedures are benign and harmless. The importance of ensuring this will be obvious if one remembers that very often the subjects are diseased people in their natural community environs.

The basic unit of interest in community medicine is the community or a population group. This implies that research priorities and interests often center on health problems and perceptions of population groups. In contrast, hospital or laboratory data are sufficient for designing research related to other medical disciplines. Critical thinking, the quality of inquisitiveness, a desire to examine and verify statements rather than accepting everything at face value as true and correct, are crucial for undertaking research in all fields. It should also be remembered that there is no end point or finite limit for research horizons. Science is a logical discipline and unravels the rationale of phenomena. Thus each research solution throws up new challenges. As Max Webber said, 'Every scientific fulfilment raises new questions—it asks to be surpassed and outdated'. A research scientist should always keep his third eye open; he should be observing even when asleep.

Why should anybody concerned with the health of population groups bother himself about research

activities? Because, health is serious business and a costly one. Interventions related to people's health must be based upon sound principles and practices which must be continuously and critically evaluated. Knowledge of research methodology is important for a doctor because in his professional career at a later date, he is often called upon to evaluate and sit in judgment whether in a teaching role, services role or administrative role.

Research tends to minimize or negate bias. Scientific techniques help one to perceive the true dimensions of a problem or a situation. Research pinpoints reasons for observed differences between two populations or groups. Research provides answers to questions relevant to daily living. Is there any danger if I consume iodised salt everyday? What should be the level of fluoridation of water supplied? Can I have two pegs of whisky every evening? At what age should my daughter be given a dose of MMR? Is there any benefit of substituting coconut oil with cotton seed oil for my cooking? And many more. There is no end to research applications.

Purpose of Research and Broad Areas of Research

As already mentioned, the reasons for undertaking research are manifold. The broad research area is determined by the purpose of undertaking research. Generally speaking, there are two broad areas of medical research.

Exploratory Research

Exploratory research is undertaken to gain new insights or to standardize procedures for more widespread application. This is often undertaken to formulate a more precise research problem or to develop a hypothesis. Examples of such types of research in medical sciences are standardization of reagents, chemicals, procedures (Fluorescein angiography in diabetic retinopathy, Sputum microscopy in tuberculosis, Standardization of OPV), etc. where the accent is on augmenting skills or procedures.

Observational Research

This is a broad area of major concern in routine research activities. It may be of three types:

PURE OBSERVATIONAL TYPE

In social sciences, a group of people can be kept under observation to study their culture or daily routine. Here the social investigator can either participate in the group activities (*participant observation*) or may just make notes on what is unraveled in front of his eyes (*nonparticipant observation*). In medical sciences such 'true' observation without any interrogation, interview or examination is usually not undertaken. The rigorous definition may be applicable to observing the number and type of people frequenting a health setup or clinic, breastfeeding practices, delivery practices of 'dais', etc.

OBSERVATIONAL INTERVIEW TYPE

These research techniques are useful in the following situations:

- When it is sought to accurately portray the characteristics of an individual, situation or a group. For example, community participation in eye camps; sexual behavior of adolescents, etc.
- When it is sought to determine frequency of occurrence of a disease, e.g. prevalence of leprosy, prevalence of smoking, prevalence of risk factors for cardiovascular disease, etc. Descriptive studies in epidemiology which are concerned with the distribution of disease in time, place and person fall in this category. Such research is generally undertaken to generate hypotheses which can then be validated by analytical techniques.

OBSERVATIONAL ANALYTICAL TYPE

Such research is undertaken to test the hypothesis of a causal relationship between a set of input and outcome variables such as hypertension and ocular pressure, smoking and lung cancer, unsafe sexual practices and AIDS, deficient dietaries and malnutrition, etc. Analytical epidemiological studies like case control and cohort studies fall in this category.

Research Approaches in Public Health

There are two broad areas of research in public health. These are:

1. Quantitative research methods
2. Qualitative research methods.

Quantitative Research Methods

These are the traditional methods used in epidemiology and clinical medicine. These are also called evidence

based research methods. Epidemiological studies, which have been described earlier like Case Control Studies, Cohort Studies, and Cross Sectional Studies are quantitative methods. Intervention studies like Community Trials and Vaccine Trials or Drug Trials are also quantitative methods. The hallmark of quantitative methods is the collection of information, which can be generalized to the population where the study has been conducted. Therefore probability sampling and determination of sample size, which will yield a statistically valid result, is of prime concern.

Surveys are an epidemiological study based on the cross sectional approach. They will be explained in greater detail in this chapter.

Qualitative Research Methods

These methods were traditionally used in behavioral sciences for a long time and have recently found application in health sciences. The common feature of these methods is that they do not primarily seek to provide quantified answers (like prevalence rates, odds ratio, etc.) to research questions. They help in understanding social phenomenon as they occur in their natural settings without any intervention. An example is to understand why and how health education messages on stopping smoking can be well known to teenagers but still they fail to give up smoking. With increasing prevalence of diseases concerned with lifestyle and behavior, there is an urgent need to understand and study these aspects in greater detail. Diabetics may continue to eat excess calories despite knowing about the need for diet control in management. Persons continue to go to commercial sex workers and have sex without a condom even after knowing that such risk behavior can result in HIV infection or STD. What characteristics lead to such behavior can be answered by qualitative research.

Since qualitative research seeks to explain social phenomenon, it is not unduly concerned with sample size and type of sampling. In fact, purposive sampling is used expensively in qualitative research. The exact expressions used by patients to describe their problems are more important than counting age, gender, socioeconomic status, frequencies, etc.

There are many types of qualitative methods. The case study, interview and observational techniques are also used in qualitative methods. Other methods like focus group discussions, consensus methods (Delphi technique), etc. are specifically used only in qualitative research. Recently a combination of qualitative and quantitative methods is being increasingly used in health.

Case Studies

The case study approach is extensively used in behavioral and medical sciences. This approach involves an in depth and intensive evaluation of one or a few cases

considered as typical or representative of a larger number of cases in a specific area. The subject of investigation may be a few characteristic individuals, a family, a community, a specific group of interest or an institution. Case studies conducted in clinics, which are so commonly utilized in medical practice, also fall in this category. The method entails a comprehensive work-up. The quantum of details collected can be phenomenal. Such detailed investigation is generally not possible in survey techniques where a large number of units are examined at the same time. The biggest drawback of this method is its inability to generalise findings on a wider scale or to a bigger group. However, the method can be effectively utilized to pinpoint data or to suggest hypotheses, which can then be tested by other more encompassing methods.

Surveys

Surveys constitute the basic tool of research in communities. There are many types of surveys such as social surveys, Gallup polls, utilisation surveys, health surveys, morbidity surveys, etc. The factor common to all surveys is that they are concerned with groups or populations rather than a few individuals. Outcome analysis in surveys represents the sum total of the group and cannot reflect each individual's concern or interests. The coverage of a survey can vary from a few individuals to a complete enumeration of the population.

Surveys provide a denominator which enables comparison, which is not possible in case studies. The denominator refers to the total number of units in which the survey was carried out such as 100,000 population; 50,000 males; 10,000 drug addicts; 5000 prostitutes; 1000 medical students, etc. There are *three basic types of surveys* that can be undertaken in the health sector:

1. *Health surveys*: A health survey is basically a program for studying a population or a particular segment of a population in order to assess its health problems or to detect conditions to which preventive measures may be applied. A health survey has a much wider connotation compared to a morbidity survey.
2. *Morbidity surveys*: A morbidity survey is a specific survey dealing with only one element in the full range of possible components of a health survey. They are concerned with disease states and their distribution in population groups.
3. *Utilization surveys*: These demonstrate how many people are utilizing services provided by specific facilities.

Uses of Surveys

Surveys are extremely useful in community medicine and help in the following ways:

- To assess the magnitude of a specific disease conditions or health-related events in specified. Communities or well-defined geographic areas.

- To guide planning of national, regional or local health programs.
- To evaluate control activities or national health programs.
- To study community perceptions and attitudes related to health and disease.
- To evaluate degree of utilization of health care facilities.
- To provide data for planning and evaluation of community intervention and health educational activities.
- To suggest and test hypotheses on health-related events and disease conditions.

The above are only the major uses. There can be many more. However, it would be clear by now that surveys are useful for research, training, planning and evaluation.

Planning for Surveys

Large scale surveys are expensive propositions. Hence they should not be undertaken unless there are compelling reasons. Before embarking on a survey, one should be reasonably sure that the information that is being sought is not available from any source. Many a time data may have been collected but it may not have been compiled or analyzed. Minimal effort to retrieve such data may be a better and cost-effective strategy than carrying out a full-scale survey.

Meticulous planning would obviate several problems that may crop up at a later stage. The planning process should carefully consider and satisfactorily answer the following questions:

- Why is the survey being undertaken?
- Where will it be carried out?
- Who all will be covered by the survey?
- When will the survey be carried out?
- What variables are to be addressed in a survey?
- Why are certain variables included and others excluded from purview?
- What instruments will be used?
- How will the survey instruments be standardised and/or validated?
- How will the survey activities be scheduled?
- What are the training needs of personnel to be involved in data collection?
- What cross-checks or supervisory modes will be used?
- How is the data to be analyzed?

If these problems are addressed at the planning stage itself, unnecessary hurdles will be avoided during the execution of the survey. It is important to remember the adage—well begun is half done.

Essential Prerequisites for Surveys

The following requirements must be fulfilled before starting a survey:

- It is essential that the permission of the appropriate administrative authority is sought and obtained before starting the survey.
- The objectives of the survey should be precise and clear. These should be defined beforehand in unambiguous terms.
- The community leaders should be contacted and all aspects of the survey should be explained to them and their cooperation solicited.
- Community health surveys should always be planned with the intent of carrying out an appropriate action program. Needless to say that a community which cooperates in a health survey legitimately expects some health benefits to accrue to its members. These could be limited to examination and referral or could also include provision of treatment facilities.
- The members of the community should preferably be told about the subsequent plan of action or follow-up activities after completion of the survey.
- As much background data as possible should be collected regarding the community where the survey is to be undertaken. This data can include demographic particulars, health facilities available, leadership patterns, other agencies working in the area, etc.
- The available resources should be carefully scrutinised. This should include money, manpower, materials, time, etc.

Survey Instruments

These can be classified into two groups:

1. Data collection instruments
 - Observation
 - Interview
 - Questionnaires and schedules
 - Projective techniques.
2. Supplementary diagnostic instruments such as hemoglobinometer, infantometer, microscope, ECG and X-ray machines, etc.

In this chapter we are only concerned with the data collection instruments.

OBSERVATION

Observation is an effective tool in social sciences. The major advantage of observation is that there is no necessity to depend on memory recall as one can record events as they unfold. In medical sciences, observation is akin to inspection procedures. They can be used to study breastfeeding or weaning practices, types of individuals frequenting STD clinics, infant behavior, time and motion studies, etc. One should be clear as to what should be observed, and how it should be recorded.

- *Unstructured observation*: Here the ground rules on how to observe and what all needs to be observed cannot be laid down in exacting terms. This generally

takes the form of participant observation where the observer collects data while participating in the activities of the group under observation. This is most useful in sociological enquiries where cultural aspects can be the focus of attention.

- *Structured observation*: This is a more systematic method and the investigator clearly knows what to observe and how to record. This method is mainly useful in situations where specific hypothesis or procedures are known beforehand.

Advantages of Observation Techniques

Observation techniques are useful as they do not depend on recall of memory. If what is to be observed is explicit, a good deal of information will be available. This can be coupled with supplementary data gathered from other sources.

Disadvantages

Not everything is amenable to observation. Discreet data, e.g. sexual behavior, cannot be observed. The time frame involved can be taxing. To observe many facets of rare occurrences may consume a lot of time. At the same time, not every group may like to be observed and the events that one wants to observe may occur too spontaneously. Climatic conditions, terrain, etc. may all interfere with undisturbed observation. These techniques cannot provide information on events which have already occurred. An individual's beliefs and perceptions cannot be adequately represented.

INTERVIEW

This is a very popular method of data collection. This method involves juxtaposition of the interviewer and the interviewee. If the interviewee does not understand a question, it can be explained to him. If more details are desired, additional queries can be posed. However, interviewing is an art. What is to be asked and how to proceed are crucial to the success of this method. Interview can be either structured or unstructured. In *unstructured interviews*, the interrogator has the freedom and leeway to proceed in any manner that he may deem judicious. In *structured interviews* the format and order of investigation is set out right at the beginning.

Interviews can be conducted irrespective of the literacy level of the interviewee. Complex psychosocial problems are better addressed by interviews. The biggest disadvantage of the interview is the probable lack of confidentiality and trust. The interviewee may be ill at ease because of the presence of the interrogator. When objectivity is crucial, standardized interviews are conducted, where the same wording and same order is retained for all respondents. Verbal method in an interview can be supplemented by visual aids.

QUESTIONNAIRES AND SCHEDULES

Questionnaires are the most commonly used survey instruments. A questionnaire is a document where questions are set out in a predetermined fashion which is filled in by the respondent himself. Questionnaires can either be administered in person or sent by post (mailed questionnaires). Mailed questionnaires are easy to administer and do not call for special skills. How the questionnaire is to be filled up is indicated in a covering note. Mailed questionnaires generally lead to a poor yield as it needs a lot of motivation to respond to the document.

Questionnaires are less expensive than other methods and a large number of respondents can be contacted in a short span of time.

The disadvantages of the questionnaire are:

1. A high level of literacy of the respondents is necessary. Illiterate respondents cannot be administered a questionnaire.
- The set questions may connote different meanings to different respondents and no explanation is possible.
 - The respondents need to be highly motivated and must have patience to properly record statements.
 - To improve yield, questionnaires need to be attractive and eye-catching.

Schedules are a recording device where the interrogator asks questions and records the respondent's answers on a document. This method is used for illiterate audiences. A set of questions are posed as in a questionnaire but the responses are filled in by the interrogator himself.

Types of Questionnaires/Schedules

Unstructured questionnaire: This is also called the interview schedule and has the advantage of greater degree of flexibility in administration. It usually contains open-ended questions so that information is provided by the respondent spontaneously in an unhindered manner. The only problem is that some respondents may not know when to stop.

Structured questionnaire/schedule: Here the sequencing and contents of the questions are decided well in advance. The respondent has to proceed in an orderly fashion. The questions can either be open or closed-ended. *Open-ended questions* have already been described. *Closed-ended questions* are those where the respondent has to select an appropriate response from among the given responses. The number of responses provided can vary from two to 'n'. Generally, not more than 4 to 5 responses are included. For example:

The objective(s) of studying community medicine is (are):

- Teaching assignments are easy
- Provides a proper perspective of communities

- Enables one to discharge social obligations
- Assures one of a WHO assignment. A combination of approaches is also possible. One can use a semi open-ended or semi closed-ended format where, if the respondent does not agree with any of the stated responses, he can cite his own reason. For example, in the above question, another option could be:
 - "Any other (please specify)."

In framing questionnaires or schedules, care should be taken to carefully formulate the questions and responses. Questions should be clear and unambiguous and should consider the sociocultural background of the respondents. Simpler and noncontroversial questions, such as those about demographic data, should be asked in the beginning. There should be a logical sequence. Questions should not be repetitive. The respondent should be able to fully answer the questionnaire in 15 to 30 minutes. It is best to avoid leading questions. As far as possible, controversial questions should be avoided. Closed-ended questions facilitate analysis.

PROJECTIVE METHODS

The major use of projective methods is in the field of psychiatry. In these methods, the framed question is designed to act as a stimulus to elicit more complex emotional information. The stimuli are capable of eliciting varied responses. For example, a rope may be perceived differently by different respondents. Similarly, an ink blot or a picture of red sauce may evoke different responses. Each type of response has a different meaning attached to it. The responses are interpreted as indicative of the respondents' personality. The responses are not taken at face value but are interpreted in some form of preestablished psychological conceptualization of what the responses to the specific test situation mean.

FOCUS GROUP DISCUSSIONS

Focus group discussions refer to a form of group interview, which capitalizes on the interactions of the members of the group to a question. For example, in a group of 8 visually impaired males aged 50+ years, the moderator asks people to comment on their experiences regarding interpersonal relationships within the family after becoming blind. All the 8 people may have something to say about their sons, daughter-in-laws, spouses, etc. and an answer given by one person may prompt another person to respond more emotionally. This is the strength of a focus group, which is not possible to capture in a one-to-one interview. The method is particularly useful for exploring people's knowledge and experiences and can be used to examine not only what people think but how they think and why they think that way.¹

A number of focus group discussions (FGDs) can be conducted for a problem. Each FGD should not consist of more than 6 to 8 people who are not known to each other earlier. An FGD should not last more than 1 – 1½ hours. All members of the FGD should share similar characteristics—Gender/Age/Social Status, etc. If there is too much disparity, interaction will not be good. If males are present, females may not speak, especially on sensitive topics. Analysis of FGD is cumbersome, as a complete record of what each person has stated has to be recorded. Even nonverbal communication is recorded. Commonly FGDs are audio taped and transcripts are then prepared and analyzed for content. The frequency with which a particular issue has been mentioned and the exact expressions used are all analyzed.

DELPHI TECHNIQUE

This is a consensus method. Such methods determine to what extent a group of experts or lay people agree or disagree on a particular topic. The Delphi technique has been used widely in health research within the fields of technology assessment, education and training, priority setting and information. It enables a large group of experts to be contacted cheaply, usually by mail with a self-administered questionnaire.

Typically, the process takes a number of ‘rounds’. In the first round, a knowledgeable group expresses opinions on a specific subject and selects suitable experts to participate in the subsequent rounds. Their comments are put in the form of a questionnaire and in the second round, the experts are asked to rank the comments given in the first round. This is then summarized and sent back to the experts in the third round to rethink on the subject. The rerankings are then analyzed for consensus. If there is no consensus, the process of repeat rounds is continued till consensus emerges.

The nominal group technique is also a consensus method. Unlike the Delphi technique, here, a highly structured meeting is planned with 9 to 12 relevant experts and decisions are taken on a specific subject of concern. A lot of groundwork needs to be done before the Nominal Group meets, unlike the Delphi technique where the initial round may have very little structuring. The following steps are used in the Nominal Group.²

- Participants in the group spend several minutes writing down their views about the topic in question.
- Each participant contributes one idea to the facilitator who records it on a flip board.
- Similar suggestions are grouped together wherever appropriate. There is group discussion to clarify and evaluate each idea.
- Each participant privately ranks each idea.
- The ranking is tabulated and presented.
- The overall ranking is discussed and reranked.

- The final rankings are tabulated and the results fed back to participants.

Designing Research Protocol

It is essential to formulate a detailed research protocol so that the research effort is meaningful and productive. The research protocol should follow a systematic format. This does not mean that the subsequent step can only be undertaken after completion of the preceding step, because there is often an overlap. However, following the format ensures that every aspect is carefully addressed. The essential steps are given below.

Selecting a Researchable Topic

A general topic of study or broad area of research may present itself in relation to some practical concern or a scientific or intellectual interest. The decision-making process may be guided by the following:

- Need for additional information on some specific disease, health care facility or service.
- Need for evaluation of the effects of a particular component of health care facilities or services.
- Need for comparing alternative treatment modalities.
- Need for future projections of the magnitude of specific health problems or health care infrastructure or services.

Formulating the Research Problem

Once the research topic is selected, the research problem needs to be formulated in detail. The following steps are useful for this purpose and have been abridged from the WHO/WPRO format:¹

- *Statement of the problem:* The first step in the development of a research project is a clear enunciation of the research problem. The statement of the problem is essential for constructing a research protocol. It guides and puts into sharper focus the research design being considered for solving the problem. It allows the investigator to describe the problem systematically and to reflect on its importance, its priority in the country or region and the rationale for undertaking the research.
- *Relevance of the problem:* It should be ensured that the problem to be researched is relevant to national, regional or local health needs and activities. It should preferably fall under the priority areas in reference to national health.
- *Field of application:* One must clearly spell out how the findings of the proposed research would benefit policy makers, health administrators or health services research scientists. It should also be indicated as to how the results would be transmitted to them.

Search for Related Work

A thorough scan of all available literature or information on the research problem should be undertaken. A review of existing information is important for the following reasons:

- It helps in further understanding of the proposed research problem and may lead to refining of the statement of the problem.
 - It helps in identifying the study variables and conceptualizing their relationships.
 - It helps in the formulation and selection of research hypotheses.
 - It helps in finding out what others have already reported on the topic, so that account can be taken of this in the design of research.
 - It provides familiarity with various methods that might be used in research. The search can be undertaken in the following ways:
 - Thorough literature scan for related work.
 - Discussion with experts in the specific area of interest.
 - First hand experience or observation.
- The sources of information include:
- i. Library catalogues, literature.
 - ii. Indices (e.g. Index Medicus and Excerpta Medica, which identify articles appearing in selected journals by subject, author and title), computer search facilities (such as Medline, Medlar, Popline).
 - iii. Bibliographies (e.g. current contents).
 - iv. Statistical reports.

Statement of Objective

Before undertaking any research investigation, its purpose should be clearly spelled out in the research protocol in terms of goals, objectives and targets. A goal is a broad definition of policy, not constrained by time. For example, an applied research project related to school health may state its goal as: “Health care facilities will be provided to maintain and improve health status of preschool children”. No mention need be made as to how the goal is to be fulfilled. This is addressed by the objectives. Objectives are defined more precisely than the goal. An *objective* is a broad statement of purpose reflecting the conditions one wants at some future time. The relationship between goals and objectives is that objectives are essentially steps towards a goal.

The specific objectives are the specific aims of the research project. What is to be accomplished is often broken down into smaller logical components. Specific objectives relate to specific research questions, which the investigator wants to answer through the proposed research. For example, the general objective “To improve ocular health of preschool children” may have the following specific objectives:

- To provide vitamin A supplementation to all under-fives
- To screen eyes of preschool children at ‘anganwadis’ at six monthly intervals
- To provide nutrition education to mothers.

A *target* is an indicator with a magnitude. It points out what should be realised by a specific date. Targets should be quantitatively measurable. They represent the measurable and attainable aims directed towards objectives which, in turn, are directed towards the ultimate goal. For example, a target may be “100 percent coverage of preschool children by vitamin A prophylaxis.”

At this stage, while objectives and targets, etc. are outlined by the investigator, it is also necessary to clarify the concepts related to the study and to give working definitions of the terms used.

It should be borne in mind that each study rests on earlier ones and provides a basis for future research efforts. More the links that can be established between a given study and other studies or a body of theory, greater the probable contribution of the study.

Selection of Variables

Variables that are sought to be measured should be clearly spelled out. The different types of variables are:

- **Independent variables (Input, antecedent, etc):** These are manipulated under study conditions to see what effect differences in them will have on those variables proposed as being dependent on them.
- **Dependent variables (Outcome, effect, etc):** These are the ones in which changes result due to the effect of the independent variables.
- **Confounding variables (Intervening variables):** These should be studied because they may influence or confound the effect of the independent variables on the dependent variable.
- **Background variables:** Variables like sex, age, race, literacy, SES, marital status, etc. are so often of relevance in investigations of groups or populations that they should be considered for possible inclusion in all studies.

The variables in a study should be clearly identified and their method of measurement as well as the unit of measurement should be clearly indicated.

Formulation of Research Hypothesis

A hypothesis can be defined as a tentative prediction or explanation of the relationship between two or more variables. Formulation of hypothesis requires the investigator to predict an answer to the research question based on knowledge of the field and logical analysis. The *formulation of a hypothesis* should:

- Suggest explanations for certain facts
- Guide in investigation of related facts
- Investigate characteristics that determine the occurrence of disease.

A hypothesis translates the problem statement into a precise, unambiguous prediction of expected outcomes. A hypothesis is not meant to be a haphazard guess. Rather, it should reflect the depth of knowledge, imagination and experience of the investigator.

The formulation and verification of a hypothesis is the major goal of scientific enquiry. The researcher should try to identify alternative competing or rival hypotheses which should then be carefully considered. Purely descriptive studies do not need a formal hypothesis.

Research Methodology

This is the most important section of the research protocol as it explicitly sets out how the protocol is to be implemented. The following items of research design have to be carefully addressed:

SELECTION OF RESEARCH STRATEGIES

This is probably the single most important decision that has to be made. Various strategies are described below. The appropriateness of a particular strategy will depend upon the problem to be researched.

Descriptive Strategies

These generate hypotheses rather than test them. Their nature will become clear by having a look at the following examples:

- Descriptive cross sectional surveys including KAP studies.
- Disease description by time, place and person. Changing patterns of health and disease over time.
- Community diagnosis of a health problem.
- Assessment of community perceptions and needs.
- Studies of existing data—case series, disease registries, surveillance records, hospital inpatient data, etc.
- Studies on the natural history of disease.

Observational Analytical Strategies

These are useful in testing formulated hypotheses. These may be of the following types:

- Prospective study (cohort study)
- Historical cohort study
- Retrospective study (casecontrol study)
- Analytical cross-sectional studies
- Follow-up studies (either longitudinal studies or cross-sectional studies repeated at intervals).

Experimental Strategies

The experimental setting may vary from a closed laboratory background to an open-field background as listed below:

- *Animal experimental studies*
- *Clinical experimental studies*: These are often labeled as randomized clinical trials (RCT). They may be diagnostic (such as comparison of barium meal and endoscopy for diagnosing peptic ulcer), therapeutic (such as comparison of a new antihypertensive drug with the current one)
- *Field trials*: e.g. vaccine trials
- *Quasi-experimental studies*: (e.g. intervention studies, health systems research, etc.).

Operational Strategies

These relate to operational aspects of a health program or facility. Observational element is an important aspect of these. Time-motion studies are a good example.

SELECTION OF RESEARCH SETTING

This includes all pertinent aspects such as characteristics of the study population, the place and time of the study and the ethical considerations. The latter are described a little later.

SAMPLING CONSIDERATIONS

The best method of studying a population is by complete enumeration of all units. This is not operationally feasible because of financial and time constraints. Hence adequate samples are drawn which are representative of all units in a population. A consideration of sampling techniques deals with the following:

- *Selection of appropriate sampling methods*: Simple, random, systematic or stratified random sampling, multiphase, multistage, cluster sampling, etc.
- *Determination of appropriate sample size*: It is the smallest number of units that is required to be studied for getting statistically valid results. Sample size depends upon the parameter measured and the research design chosen. As a general rule more the variance or standard deviation, more the sample size.
- *Minimizing sampling errors*: By ensuring representativeness and reliability of the sample.

CONTROLS

Controls are used to increase the validity of results. Controls are comparable units drawn from similar population groups which are similar in most respects except that exposure to the risk factor or disease condition is lacking. Controls should be matched on as many of the confounding variables as possible. For example, they may be drawn from the general population, other family members or hospitalized patients not afflicted by the same disease.

In experimental situations, “controls” are those individuals who are not administered an experimental

stimulus (for example, individuals given placebo in contrast to individuals receiving the trial drug, who constitute the experimental group). When cause and effect relationships are not being considered, there is no need for a control group.

DESCRIPTION OF STUDY INSTRUMENTS

The study instruments used in research protocols have already been discussed. The questionnaires, interview schedules, other methods of observation and the recording forms, etc. should be explained in detail.

DESCRIPTION OF DATA COLLECTION

The method of collection of data should also be spelled out in full detail. How the community would be approached, how investigators would be selected, how their training needs would be assessed and how they would be trained — all these aspects need to be described. So also, there is a need to specify job responsibilities of each member of the data collection team, methods of supervision and cross checking and the logistic support and supplies. Persons responsible for field verification of data should be identified. Large studies should be preceded by a pilot study which should include pretesting of forms and schedules.

- **Pretests:** Pretesting is the system of validating the study instruments and procedures. It is a method of standardization of the instrument as well as the personnel who will administer the instrument. Pretesting helps in the following ways:
 - It tests the clarity of the framed questions. It examines whether the questions in the form are understood similarly by many people or whether their perceptions vary greatly. In India, questionnaires and schedules have often to be translated into local languages. Hence it is desirable to see whether the translation agrees with the original.
 - It tests acceptability of the questions. It looks into whether people answer the questions happily or whether they take offence to some questions.
 - It tests logical sequencing of questions.

After pretesting, the questionnaire should be modified in the light of the experience gained.

- **Pilot studies:** A pilot study is akin to a full dress rehearsal. It can be defined as a program of predetermined duration and on a restricted scale which should serve as a model for extended or general application, if it proves to be feasible, effective and sufficiently efficient. A pilot phase helps to validate whether all components of the system are functioning smoothly or not. The pilot phase should have a duration long enough to detect weaknesses and constraints in the system. Pretesting of the instruments and procedures should have been completed before embarking on the pilot study.

A pilot study can also be utilised for determining the sample size. In many situations, information on the prevalence and other variables of a disease (which is essential for determining the sample size) is not available. The pilot study can be used to obtain such information.

If a pilot study shows that certain components are not feasible, a modification should be incorporated in the research design. The modified research plan should again be validated through a pilot study before the main research protocol is implemented.

DESCRIPTION OF PLANS FOR DATA ANALYSIS AND INTERPRETATION OF RESULTS

The plan for analysis of data is an integral part of the research design and should be incorporated into the research proposal itself. Preparing such plan helps the investigator in avoiding several pitfalls, such as, discovering at the end of the study that some needed information has not been collected, or that the information collected is not appropriate for statistical analysis. The description should include the following:

- Design of the forms for data processing.
- Overall data processing plan and a statement whether the data will be processed by hand or by computer.
- Coding plan in case of computer processing.
- Personnel to be involved in verification of data, data entry and handling and data retrieval.
- Choice of statistical methods to be employed.

REPORTING AND PUBLISHING OF RESULTS

The prime aim of undertaking research is to validate selected hypotheses and to disseminate information which will be useful for future research. The scientific community at large should be able to benefit from the research results. Hence a comprehensive report is desirable and wide dissemination, using all available channels of communication, is essential.

Ethical Considerations in Research

Any research activity conducted in a human population has to be carefully reviewed in terms of ethical implications. Once a community participates in a research project, it logically expects some corollary medical benefits to accrue. Some part of the budget should be earmarked for this purpose.

Since most persons in a general population do not suffer from a disease condition, it is essential that the examination procedures used in the study are completely harmless and noninvasive.

A careful consideration of what is to be done for those people who were not selected in the final sample is also important. Any intervention in the community should not be restricted solely to those who were

sampled or who participated in a trial. At the completion of the investigation, the researchers have a responsibility to share results with the community.

Ethical considerations are more rigid in intervention studies. Informed consent must be obtained from all participants. They must be clearly told about the objectives, salient features of methodology, adverse reactions, placebo effect, etc. Confidentiality should be ensured. The poorer sections of the community should not be exploited in research that will mainly benefit the more wealthy and privileged sections. It would be unethical to institute costly therapy in poor patients and to discontinue treatment after completion of the research project without providing medication for the remainder of the course.

Every institution has an ethical committee. All proposals are carefully screened by this committee. If a new drug or dosage formulation is to be used, it should be done only after seeking permission of the drug controller.

Ethics committee (EC), also known as **Institutional Review Board (IRB)**, **Institutional Ethics Committee (IEC)** and **Ethics Review Board (ERB)** constituted of medical, scientific and non-scientific members, whose responsibility is to ensure the protection of the rights, safety and well being of human subjects involved in a study. Among other things-reviewing, approving and providing continuing review of study protocol and amendments and of the methods and material to be used in obtaining and documenting informed consent of the study subjects.

Ethical Guidelines for Biomedical Research on Human Subjects

In 2000 AD, ICMR has brought out guidelines for research which need to be followed by all individuals/institutions. ICMR has highlighted the following principles for undertaking research:

- **Principles of essentiality:** Research on human subjects should be done only if all other avenues of research have been considered.
- **Principle of voluntariness, informed consent and community agreement:** Subjects are fully apprised of the research and the impact and risk of participating in the research. These are cardinal principles and must be adhered to.
- **Principles of nonexploitation:** Subjects should be remunerated for their participation and complete

information on procedures, risks and affects should be shared. Remedial action and comprehensive after care should be provided to all subjects.

- **Principles of privacy and confidentiality:** Identity and records of all subjects should be kept confidential.
- **Principle of precaution and risk minimization:** Due care and caution should be taken at all stages of research.
- **Principles of professional competence:** Research should be conducted at all times by competent and qualified persons with total integrity and impartiality.
- **Principles of accountability and transparency:** Fair and honest research is essential and if necessary, all records should be produced in front of appropriate legal and administrative authorities.
- **Principles of maximization of public interest and distributive justice:** Research should be done to benefit all human kind and not just those who are socially better off. All reports and records should be duly preserved.
- **Principles of public domain:** All research should be brought into public domain and published to share findings in scientific and other publications in accordance with the relevant law of the country.
- **Principles of totality of responsibility:** Professional and moral responsibility should be upheld and regular monitoring done while research is being undertaken.
- **Principles of compliance:** The letter and spirit of these guidelines should be followed.

These 12 principles are common to all areas of biomedical research in the country. Every Institution must have an Institutional Ethical Committee, which should comprise of a minimum of 5 and maximum of 15 persons. It should have basic medical scientists, clinicians, legal experts/retired judge, and social scientist/representatives from NGOs, philosophers/ethicist/theologian and, at least, one person from the lay public.

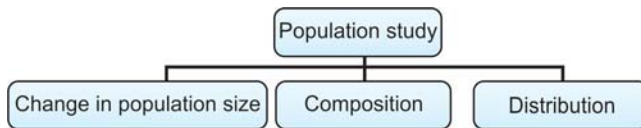
Detailed guidelines are available from ICMR and an Ethics Committee in accordance with the principles laid down by ICMR should clear a research proposal before the research is initiated.

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Demography

The term demography refers to the scientific study of human populations as regards their size, composition and distribution.



The science of demography includes the study of five demographic processes, viz. **marriage, fertility, mortality, migration and social mobility**. The numerical data related to these five processes are known as demographic statistics. The term vital statistics includes the statistics relating to vital events like birth, death and marriage. *Morbidity statistics* are also included in this chapter for the sake of convenience though not really a part of demography. These statistics form the eyes and ears of public health and medical administrators.

Demography is primarily a descriptive discipline almost devoid of basic theory. When attempting to “explain” the underlying factors in population size, composition, or distribution, demographers rely heavily upon the theories of economics, human ecology, sociology, social psychology, psychology and biology. For this reason, demographers are usually specialists in some broader area, such as sociology or economics. In general, demography may be said to be synonymous with population analysis. In this chapter we shall first review the basic demographic concepts followed by a discussion of the vital statistics.

Demographic Transition

Preindustrial societies had a high birth rate and death rate, which rather balanced each other, resulting in very slow population growth rate. These rates were of the magnitude of 36-45 per 1000 population. Industrialisation brought in its wake newer and more widespread preventive, promotive and curative approaches, resulting in decreased fertility and mortality. Within this broad framework, **five demographic stages** have been recognised. In a classical situation, a country or a society would pass through these five stages sequentially. It may be mentioned that sometimes these five stages are

described as components of a so called “*demographic cycle*.” Strictly speaking, this is wrong. The concept of a cycle implies that from stage 5, we again come to stage 1 in a cyclic fashion. This, of course, is not so.

Demographic Gap

Difference between birth rate and death rate is called demographic gap. This wide gap leads to population explosion (**Fig. 25.1**).

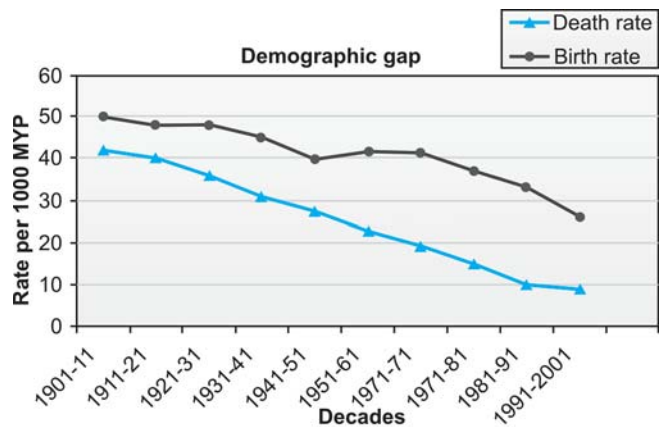


Fig. 25.1: Demographic gap (based on hypothetical data)

Demographic Stages

1. **First stage (High stationary stage):** This is the stage of high birth and death rates, which nearly balance each other. The population remains rather stationary. India was in this stage till 1920.
2. **Second stage (Early expanding):** Death rate declines while fertility remains unaltered. The result is rapid population increase. Many countries in Africa and South Asia are in this phase.
3. **Third stage (Late expanding):** Birth rate starts declining, while death rate falls still further. Population continues to increase. India is in this stage at present.
4. **Fourth stage (Low stationary):** This is the stage of stable population when birth and death rates are low and balance each other. Many countries in the West are in this stage of *zero population growth*. Examples are: Austria, Sweden, Denmark and Belgium. With the onset of this stage, a country is said to have undergone *demographic transition*.

5. **Fifth stage (Declining):** Birth rate is lower than the death rate. Population declines. Hungary is the only example with an annual population growth rate of minus 0.1%.¹

Growth Rate

Growth of population can be measured by growth rate, which is calculated by the difference between the crude birth rate and crude death rate expressed as percentage.

Population Trends in the World

World population was about 250 million 2000 years ago and 1000 million 200 years ago. Thus it took 1800 years for a four times increase. Interestingly, the further quadrupling of population to 4000 million took only 75 years. World population reached 6.1 billion by mid 2000 and is currently growing at an annual rate of 1.2% or 77 million people each year. Six countries account for half of this annual growth—India for 21%, China for 12%, Pakistan for 5%, Nigeria for 4%, Bangladesh for 4% and Indonesia for 3%. By 2025 AD, the world population is expected to be between 7.9 billion (low projection) to 10.9 billion (high projection). The population of the more developed countries which is currently 1.2 billion, is not expected to change much over the next 50 years. In fact, for 39 countries, including Japan, Germany, Hungary, Italy, Russia, Ukraine, Georgia, the population is expected to decrease. At the same time, the population of the less developed countries is projected to rise steadily from 4.9 billion in 2000 AD to 8.2 billion by 2050 AD. If fertility levels do not come down, it may increase to 11.9 billion.²

ESTIMATES OF WORLD POPULATION (TABLE 25.1)

What is the cause of this rapid increase in population in the present century from 1.6 billion in 1900 to more than 6 billion estimated in 2000 AD? For understanding this, the concept of “doubling time” is useful. Doubling time implies the time needed for the population to double. More the growth rate of population, less the doubling time. It is seen from the table above that annual world population growth rate had always been

Years	Population (Billions)	Annual growth rate (%)
1750	0.8	—
1800	1.0	0.4
1850	1.3	0.5
1900	1.6	0.6
1950	2.5	1.1
1975	4.1	1.89
1987	5.0	1.63
2000	6.1	1.2

Note: 1 billion = 1000 million

below one till the beginning of the twentieth century. It is only during this century that it started increasing, from 0.6 in 1900 to 1.1, 1.79 and 1.92 in 1950, 1960 and 1970 respectively, with moderate decrease thereafter. The relation between population growth rate and doubling time is given in **Table 25.2**.

DOUBLING TIME OF WORLD POPULATION (TABLE 25.3)

The three most populous countries of the world today are China, India and USA, with populations of 1285 million (2001), 1027 million (2001) and 286 million (2001) respectively. Four fifths of the world population lives in the developing countries of Asia, Africa and Latin America. The high growth rate in developing countries accounts for the major portion of population increase in the world as seen in **Table 25.4** on World Population Growth Trends.

The annual world population growth rate was around 0.5% during the last two centuries, and increased to about 1% during the middle of the present century. It reached its peak in 1970, at 1.92%. It has been gradually declining since then. In 2001 it has come down to 1.2%.

Population Trends in India

Growth of population in India since the beginning of this century is seen in **Table 25.5** “Population of India (1901-2001)”. It is obvious that we are adding 1.6 corer people every year, equivalent to the combined population of Haryana and Himachal Pradesh.

Some important features in the population profile of India are summarized below. The urgency of reducing population growth is obvious from the fact that India has only 2.4% of world’s land area, yet sustains 16% of world population.

Annual growth rate (%)	Doubling time (years)
1.5-2.0	35-47
1.0-1.5	47-70
0.5-1	70-139

Population (billions) and years		Doubling time (years)
From	To	
0.8	1.6	150
(1750)	(1900)	
1.25	2.5	100
(1850)	(1950)	
2.5	5.0	37
(1950)	(1987)	
3.0	6.1	40
(1960)	(2000)	

TABLE 25.4: Comparison of population characteristic between developed and developing countries

Characteristics	Developing countries	Developing countries
Stages in demographic cycle	Majority are in Early or late expanding stages	Majority are in low stationary and few in decline stages
Sharing of population	About 80% of world popn live in developing countries (Asia, Africa and latin America) India (16%) and China (20%)	20% of world popn live in this area
Birth Rate	In India 23.1/1000 population (NFHS-3 in 2005-06)	About 11-13/1000 population
Growth rate	It varies between 2.2-3%. In India	It is less than 0.5%
Age sex composition (Population pyramid)	Young age group (<14 year) constitute 39 % of population. High working group of population (low dependency ratio) represent both a challenge and opportunity. Broad base with tapering tip (India)	Young age group (<14 yr) constitute 23 % of population. 15- 50 yrs consist of 12 %. Grater proportion of geriatric popn Narrow base with bulge in middle
Sex ratio	Adverse to female (940/1000 male as per 2011 census)	Favorable to females
population density	Higher	Low
Family size (TFR)	Fairly high in India (4.5)	Smaller, Switzerland (1.5)
Population density	Higher	Lower
Urban population	¼ live in urban area (27.9 % of total)	3/4th
Life expectancy	64.7 (2011)	75 year
Literacy	Low (74.02% in 2011)	High

Population of India (1901-2001)

TABLE 25.5: Population of India in million (1901-2001)

Census year	Total population (million)	Increase (Absolute No.) (in million)	Growth rate (%)	Birth rate	Death rate
1901	238.4				
1911	252.1	13.6	0.56	49.2	46.2
1921	251.3	-0.7	-0.03	48.1	47.2
1931	279.0	27.6	+1.04	46.4	36.3
1941	318.7	39.7	+1.33	45.2	31.2
1951	361.1	42.4	+1.25	39.9	27.4
1961	439.2	77.7	+1.96	41.7	22.8
1971	548.2	108.9	+2.20	41.2	19.0
1981	683.3	135.2	+2.22	37.2	15.0
1991	844.0	160.6	+2.11	29.5	9.8
2001	1027.0	183.0	+2.13	26.1*	8.7*
Goal (2001)				21.0	9.0

*Source: SRS data, 1999.

Population Profile of India³

- Large population base [2.4% of land area and 16% of world population].
- Rapid population growth and low economic development
- Young age distribution
- Low female age at marriage [1981:% married, 10 to 14 years 6.2, 15 to 19 years 43.4].
- High fertility and typical reproductive pattern [4.0 births; too early and too frequent].

- Low death, though high infant and child mortality.
- High morbidity of mothers and children
- High rate of urbanization
- Sex ratio unfavorable to females.
 - 940 females per 1000 males in 2011.

In view of this urgency, definite demographic targets to be achieved were fixed at the national level for 1990 and 2000. These targets, and the extent to which these have been realized, are shown below in **Table 25.6**.

TABLE 25.6: Some goals of demographic indicators against the program achievements

Indicators	Achievements	Goals for	
		1990	2000
Infant mortality rate	70 (1999) 80 (1990)		Below 60
Crude death rate	8.7 (1999) 9.6 (1990)	10.4	9.0
Life expectancy at birth			
M	62.4 (1996-2001)	57.6	64
F	63.4 (1996-2001)	57.1	64
Effective couple protection rate	43.3 (1990) 46.2 (1999)	42.0	60
Crude birth rate	26.1 (1999) 30.2 (1990)	27.0	21.0

World Population Day: 11th July

The following initiatives have been emphasized.⁴

- Vigorous campaign for a meaningful girl child education.
- Increasing the age of marriage especially for girls and delaying the birth of first child.
- Birth spacing – a minimum of three years between each child and change in mindset towards son preference.
- Reduction of IMR and MMR and meeting the unmet need for family welfare.
- Male involvement in family welfare.
- Special focus on family welfare in the high fertility states.

Vital Statistics

Uses and Applications of Vital Statistics

Vital statistics constitute an essential tool in demography (statistical study of population) and public health. They provide answers to various health related questions, such as:

- What are the leading causes of morbidity and mortality? What are their trends over a period as regards severity and prevalence?
- What is the age, sex, class and areawise distribution of various variables?
- What is the composition of the population and what are the future trends?
- Which health program should be given priority and what are the requirements for the same?

The subject of vital statistics may be discussed under four headings: Collection, Compilation, Analysis and Interpretation.

Collection of Vital Statistics

The vital statistical system deals with the individual's entrance into and departure from the world and with

change in the marital status. The concerned events are birth, death, marriage and divorce. It is useful in socio-economic planning and in planning of health and family welfare services. In India vital statistics are obtained from (i) Population census (ii) Civil registration system (iii) Sample registration system (iv) Adhoc sample surveys (v) Rural survey of cause of death (vi) Medical certification of causes of death (vii) Institutional records, etc.

SOURCES OF DATA

Population Census

Census means the enumeration of the total population of the people in a country at a given moment of time. It is defined by the United Nations as “the total process of collecting, compiling and publishing demographic, economic and social data pertaining at a specified time or times to all persons in a country or a delimited territory.”

Census is normally conducted at fixed intervals. In India, it is carried out once every 10 years in the first year of each decade on dates specified by the Registrar General of India. The first all India census was carried out in 1881. Till 1931, the census was carried out on *de facto* basis, also referred to as the date system, under which, on the date of counting, on a particular night, a person is presumed to belong to the place where he is found. The process of completing the census on the night was not operationally feasible to enumerate all individuals. Since 1941, the system accounted for all individuals permanently resident at one place, irrespective of whether he was present there or not at that particular time. This is the *de Jure* system which is followed till date.

The census provides useful demographic and social data about age, sex, marital status, language, education, occupation, economic status, place of birth, number of children born alive to a woman, etc. Such data are useful for:

- Socioeconomic planning and planning of health and family welfare services.
- Finding the growth rate of population.
- Calculating the indices like birth, death and morbidity rates.

Problems in census operation: Errors may creep in census data due to the following shortcomings at the data collection stage:

- The terms used in the proformas for collection of information may be interpreted differently by different enumerators.
- There is shortage of trained manpower to collect and process the information.
- Census field work is extremely tedious. Dishonest field workers manipulate figures to give wrong results.
- Many people do not give correct information due to failure on the part of the investigator to establish proper rapport with them.

- Age is often recorded in multiples of 5 years. The importance of recording actual age is not understood by the investigators.
Since the census is a costly exercise in terms of men, money and materials, all efforts should be made to minimise the above errors.

Salient Features of 2011 Census⁵⁻⁷

- The slogan of Census 2011 is “Our Census, Our Future”, and is the 7th census after independence and 15th census since 1872.
- Census was conducted in two phases: (i) House listing and housing census, and (ii) Population enumeration phase. The first phase of the Census was conducted in the period April to September, 2010 in different States/Union Territories. The field work of the second phase (Population Enumeration) was carried out during February-March, 2011. Each and every household was visited by enumerators to collect details such as name, date of birth, sex, present address, permanent address, names of father, mother and spouse, and use of mobile, computer, internet, etc. After 1931, a head count based on castes was taken up after a gap of 79 years. Biometrics such as photograph, 10 fingerprints and probably Iris information will also be added later on for all persons aged 15 years and above.
- There were two forms for each household. The first form related to building material, use of houses, drinking water, type of latrines, electricity, possession of assets, etc. The second form relates to the National Population Register and includes different demographic data.
- The register will include photographs of all population and the entire population of the country will be under one database. President Pratibha Patil was the first person enumerated. Each resident will receive a Unique Identity Number (UID) based on biometrics. The UID will be a smart card with UID number and include details like name, sex, birth and family details alongwith photograph of citizen.
- This census covered 7936 towns and over 641,000 villages from 35 states and union territories of India. Some of the most salient findings are: a declining population growth, increasing literacy rates, and a reduced sex ratio.
- By the end of 2010, with a population of over 1210.2 million, India alone accounted for 17.5% of the world population. Overall population has increased from 1.03 billion in 2001 to 1.21 billion by 2010, the population growth rate has experienced steepest ever decline since India's independence in 1947. While the population growth rate between 1991 and 2001 was 21.54%, during the last decade the growth has been reduced

17.64%, an annual growth rate of 1.76%. If this growth rate persists then India can surpass China as the world's most populous country by 2030.

- Overall literacy rate has increased from 64.83% in 2001 to 74.02% in 2011, though this increase is not uniform throughout India. While some districts, such as Serchhip district in Mizoram—a North Eastern state, registered the highest literacy rate of 98.76%, another district, Alirajpur, in Madhya Pradesh—a central Indian state, remains at the bottom with only 37.22% literacy rate. While the male literacy rate is 82.14%, the figure for female literacy rate is 65.46%.
- Sex ratio being 940 females for every 1000 males, as compared to 933 in 2001. This sex ratio is also not homogeneous. This highest sex ratio observed is 1176 in Mahe district while the district Daman registers the lowest sex ratio of only 533. The reasons for such a low sex ratio range from illegal abortion of female child, to female feticide, to female infanticide.

Registration of Vital Events

It is done on a continuous basis by various agencies responsible for vital statistics in different states. These agencies are of four types—Panchayat, Revenue, Police, and Health. In some states (e.g. Bihar, UP, Rajasthan) the information about birth and death is collected by the Panchayat system. In states like Andhra Pradesh, Tamil Nadu and Karnataka, this information is collected through the revenue system (Tehsildar, village munsif, etc.). The police is responsible for this activity in states like Haryana, Punjab and J and K. Oddly enough, this information is directly collected by the health department only in a few states (Kerala, Orissa and West Bengal). This is in spite of the fact that the occurrence of life and death are of primary concern to the health sector. The civil registration system is shown in **Figure 25.2**.

It is obvious from the foregoing that there is no uniformity in the system of reporting of births and deaths. This is further reflected in the fact that even at the state level, this information is centralized variously either at the level of Director of Health or the Director of Statistics. The State Directors send the information to the Director-General of Health.

Services and Registrar-General in Delhi, who, in turn supply necessary reports to the WHO and other international agencies.

Voluntary registration of vital events started in India after the passage of the Births, Deaths and Marriages Registration Act in 1866. Some erst while states like Madras and Mysore made the registration compulsory.

Earlier, over 30% of births and notifiable infectious diseases like smallpox, cholera and plague went unrecorded due to defects in reporting and registration of

vital events. The problems included lack of interest and illiteracy on the part of parents, indifference on the part of reporters and registrars who were poorly paid, poor communications, etc. Registration improved to some extent after responsibility was passed onto the Panchayats. Still, compared to the data obtained from sample surveys, the proportion of unregistered events was pretty high and the registered data was not reliable. Hence, the Government of India passed the Registration of Births and Deaths Act, 1969. It provides for compulsory registration of births within the period notified. This period is 21 days in Delhi both for births and deaths. Defaulters are punishable. The Secretaries of Panchayats and Municipalities and the Health Officers are designated as Registrars and the District Health Officers, as District Registrars. The State Director of Health Services and Deputy Director or Assistant Director (I/C Statistics) are designated as Chief and Deputy Chief Registrars of Births and Deaths respectively. The Central Government has appointed one Registrar-General at Delhi.

Forms for birth registration should include information regarding date and place of occurrence, sex, type of birth, attendant at birth and date of registration. In case of death, age, sex, place, attendant, residence and cause of death have to be mentioned. The drawback is that information regarding the cause of death, as provided by the informant, is accepted without any probing. However, hospital data make a distinction between the underlying and immediate cause of death and the former are tabulated according to the International Classification of Diseases (ICD).

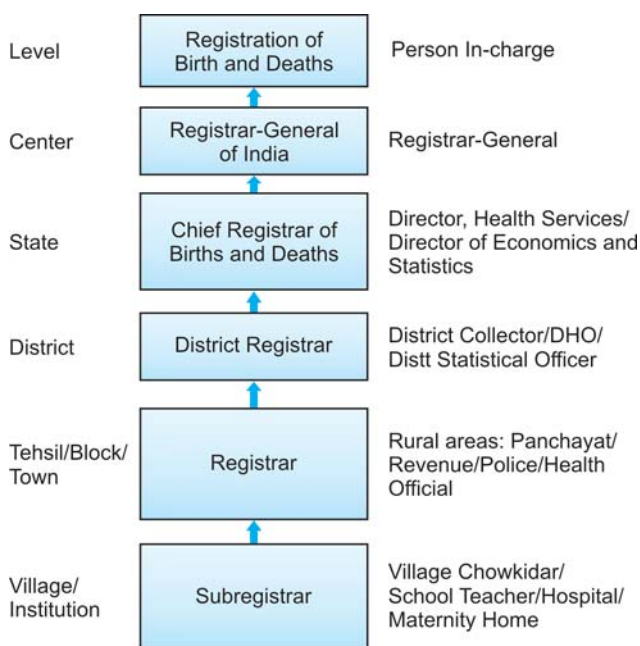


Fig. 25.2: The civil registration system

Notification of Diseases

Notification of certain communicable diseases is compulsory throughout India on the part of Panchayat Secretaries in villages and doctors in towns. These records are maintained by the District and Municipal Health Officers in districts and towns, the Directors of Health Services in the states and the Director-General of Health Services at the center. The epidemiological statistics of communicable diseases is collected from the National governments by the regional offices of the WHO and are published periodically in the form of the Annual and Monthly Epidemiological and Vital Statistics Records and the Weekly Epidemiological Records. The diseases to be notified vary from country to country and from region to region within the same country. The three diseases that are internationally notifiable to the WHO at present are cholera, plague, and yellow fever.

Institutional Records

Hospitals, primary health centers and maternity homes prepare monthly returns of indoor and outdoor cases and send them to the State Director. These data are biased but give a gross picture of the diseases prevalent in the catchment area of the institution and are often used to assess hospitals needs and efficacy of certain therapeutic measures.

Community Surveys

Health, nutrition and morbidity surveys are conducted in certain communities from time to time. These surveys, if conducted properly using sound sampling procedure and epidemiological principles, are a very useful source of information. Community surveys may also be carried out specifically to find the prevalence or incidence of specific conditions such as tuberculosis, leprosy, malaria, cancer, obesity, protein, energy malnutrition and goiter.

National Sample Survey

The National Sample Survey (NSS), started in 1950-51, is a continuous activity undertaken by the Central Government on all India basis to collect data relating to social, economic and demographic aspects. The National Nutrition Monitoring Bureau (NNMB), located at the National Institute of Nutrition, Hyderabad, is specifically engaged in collecting nutritional data in the field on a predefined sample. Other central agencies concerned with various statistical data, including vital statistics, are Central Statistical Organization (CSO), Registrar-General of India and the Bureau of Health Statistics within the Central Ministry of Health.

Sample Registration System (SRS)

In the absence of dependable data term civil registration, the office of the Registrar-General of India initiated a

scheme of sample registration of births and deaths in 1964-65 in a few selected states. Now this system covers the entire country. It is based upon a dual recording system comprising of continuous registration of vital events along with half-yearly retrospective survey, each providing a check on the other. The main objective of the system is to provide reliable estimates of vital rates at the state and national level. The essential features of SRS are:

- A base-line survey of the sample unit to obtain the usual resident population of the sample area through a household schedule.
- Continuous (longitudinal) enumeration of vital events pertaining to the usual resident population by a locally resident enumerator. This continuous enumeration is done by part time enumerators, who are generally school teachers paid an honorarium for this work. Each enumerator appoints specified informants in his area and whenever information is provided, he visits the specified household. In addition, he conducts fortnightly visits.
- An independent yearly survey of births and deaths by an investigator (supervisor) who is a full time employee. Each supervisor is in-charge of 12 enumerators.
- Matching of events reported by the two systems.
- Field reverification of unmatched and partially matched events.
- Estimation of missing events by the investigator and supervisor, using a well defined technique known as the Chandrasekharan Demmy formula.

The sample unit in rural areas is a village or a segment if the village has a population of 1500 or more. In urban areas, the sample unit is a census enumeration block with a population ranging from 750 to 1000.

- The only source for fertility and mortality data since 1969-70.
- Largest demographic survey in the country covering about 1.4 million households and 7.01 million population in 7597 sample units across 35 States/Uts.
- Since 2004, a system of collection of Causes of Death data through Verbal Autopsy has also been included under the domain of SRS.
- This system allows for tracking Millennium Development Goals (MDG) on Child Mortality and Maternal Health on a regular basis Sample Registration System (SRS).
- MDGs are a set of numerical and time-bound targets to measure achievements in human and social development laid down by the UN.
- Of the 8 MDGs, IMR, U5MR and MMR are generated by SRS.⁸

Goal No.	Goals	Indicators	Target by 2015
5	Improve maternal health	Maternal Mortality Ratio (MMR)	109
4	Reduce infant mortality	Infant Mortality Rate (IMR)	28
	Reduce child mortality	Under 5 Mortality Rate (U5MR)	42

Model Registration System

Generation of morbidity statistics forms an integral part of vital statistics system. However, due to paucity of qualified medical personnel in rural areas, medical certification of cause of death is not feasible in India. A conference on improvement of vital statistics was held in April 1961. Based on its recommendations, the Registrar-General of India initiated in 1965 a scheme called Model Registration Scheme on a limited scale. This scheme is now known as “Rural Survey of Cause of Deaths.” Currently, this scheme covers more than 1000 PHCs and seeks to collect data on causes of death, through paramedical personnel, in the headquarters village of the PHC only. The deaths are classified according to an adopted nonmedical list. It is not a sample survey as the units are not selected randomly but according to convenience. The causes of death reported are checked by the medical officer of the concerned PHC and every 10th death is verified by the MO.⁹

Miscellaneous Sources

These include health departments of factories and insurance companies.

INTERNATIONAL DEFINITIONS

In 1953, the United Nations approved the principles for a Vital Statistics System. The guidelines for this were published in 1955. These were aimed at helping the member countries to develop a uniform system of registration, interpretation and comparison of vital events. Various vital events have been defined by the WHO as follows:

Live birth: Live birth is the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles. Whether or not the umbilical cord has been cut or the placenta is, attached, each product of such a birth is considered live-born. It may be mentioned that under the Indian “Registration of Births and Deaths Act, 1969” birth includes both live birth and stillbirth.

Fetal death: Fetal death is death prior to the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy. The death is indicated by the fact that, after such separation, the fetus does not breathe or show any other evidence of life, such as beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles.

Stillbirth: It is synonymous with late fetal death, i.e. twenty-eight completed weeks of gestation.

Immaturity (prematurity): In international classification of disease, an immature infant is a liveborn infant

with a birth weight of 2500 g (5.5 lbs) or less. In some countries a live-born infant with a period of gestation less than 37 weeks is specified as ‘premature’ regardless of weight. Such premature infant may be considered as ‘immature’ in International Classification.

Death: “Death is the permanent disappearance of all evidence of life at any time after live birth has taken place” (postnatal cessation of vital functions without capability of resuscitation).

Infant deaths: Deaths under one year of age.

Neonatal deaths: Deaths occurring under 28 days of age.

Perinatal deaths: Deaths occurring after 28 weeks of fetal life and within 7 days after birth. It is often difficult to know the correct fetal age. In such situation, fetal weight of 1000 gm is considered to represent gestational age of 28 weeks, as suggested by the Ninth Revision (1975) of International Classification of Diseases. If both gestational age and birth weight are unknown, then a body length (crown to heel) of 35 cm is taken as equivalent to 28 weeks gestational age.

Maternal deaths: Deaths associated with complications of pregnancy, childbirth and puerperium.

GENERAL PRACTITIONER AND VITAL STATISTICS

The general practitioner can play an important role in improving the registration of vital events and collection of health statistics as described below:

Births: The medical man often attends upon a pregnant woman during antenatal, natal or postnatal period. He is also called upon to treat the infant.

He is aware of the fact of birth and is also conversant with the mode of notification and its importance. He is thus in a unique position to advise and influence the parents and relatives to get the event of birth registered.

Deaths: He should certify the cause of death in the prescribed form for death certificate which he should send to the Registrar.

Notifiable morbidity: He should notify all notifiable diseases properly and correctly to health authorities. If he keeps records of all illnesses, as a good general practitioner should do, he can help in the survey of some health problems.

INTERNATIONAL DEATH CERTIFICATE

All medical practitioners should be familiar with the filling of the International Certificate of Death. The format of the certificate is given in **Figure 25.3**. A modified form of the same is given in **Figure 25.4**.

Compilation, Tabulation and Presentation of Statistics

This is done by the Bureaus of Health Statistics at the State level and by the Central Bureau of Health Intelligence (CBHI) at the Directorate General of Health Services. The latter publishes weekly, monthly, quarterly and annual reports.

The methods of presentation of data through tables and drawings have been discussed already in Chapter 23.

Analysis of Vital Data

CALCULATION OF VITAL AND HEALTH INDICES

Vital and morbidity indices are calculated as “rates” or “ratios”, using the mid-year population (i.e. on first July) as a denominator.

MID-YEAR POPULATION

Three methods are used to find the mid-year population:

Natural Increase Method

This is done by adding the increase due to births and immigration to the last census population and subtracting from it the loss due to deaths and emigration. This method requires cent per cent

CAUSE OF DEATH		Approximate interval between onset and death
I		
<i>Disease or condition directly leading to death*</i>	a. Bronchopneumonia due to (or as consequence of)	
<i>Antecedent causes</i>	b. Due to (or as a consequence of)	
	c. Strangulated hernia	
Morbid conditions, if any, giving rise to the above cause, stating the underlying condition last		
II		
Other significant conditions contributing to the death, but not related to the disease or condition causing it	Diabetes	

*This does not mean the mode of dying, e.g. heart failure, asthenia, etc. It means, the disease injury or complication which caused death.

Fig. 25.3: Sample of international form of death certificate

Medical Practitioner (rubber stamp) or Name of Institution		Allopathic, Ayurvedic Homeopathic, Unani		Serial number of Institution	Date of Notification
Name of Deceased Address		Occupation		Date of Death	
Sex	Religion	Age	If under one year Months Days	If within 24 hours Hours Minutes	
CAUSE OF DEATH					Interval between onset and death
I					e.g. 5 days
Disease or condition leading to death. (This does not mean the mode of dying, e.g. heart failure, asthenia, etc. It means the disease, injury or complication which caused death) <i>Antecedent causes</i>			a. Toxemia due to (or as consequence of)		
Morbidity conditions, if any, giving rise to the above cause, stating the underlying condition last			b. Gangrene of the right leg due to (or as a consequence of)		
II					e.g. 7 days
Other significant conditions contributing to the death but not related to the disease or condition causing it.			c. Diabetes mellitus Pulmonary tuberculosis		
Accident, Suicide, Homicide (Specify)				How did the injury occur?	
Signature of Medical Attendant				Address of the Signatory	

Fig. 25.4: Sample of international form of death certificate (Modified)¹⁰

recording of births, deaths, and migration and is not practicable in our country.

Arithmetic Progression Method

It is assumed that population increases equally in each year of the intercensal period. It is found by the formula:

$$P_n = PC_1 + a (PC_2 - PC_1)/10$$

where P_n denotes mid-year population of any given year.

PC_1 and PC_2 indicate the population of the last two censuses and a is the period in years after the last census.

Example 1: The population of a city was 2,80,000 as per March, 1981 census and 2,10,000 as per March, 1971 census. Calculate the mid-year population for 1985.

$$\text{Increase in 10 years} = 2,80,000 - 2,10,000$$

$$\text{Average increase per year} = 7000$$

To find mid-year population of 1985

$$2,80,000 + \frac{1}{4-3} (7000) = 2,80,000 + 30,333 = 3,10,333$$

Geometric Progression Method

Here it is assumed that population increases like compound interest and the rate of growth is geometric and not arithmetic. If 'PC' is the population of any census year and 'r' is the rate of increase per year per person in the intercensal years, then mid-year population at the year will be $P(1+r)^n$.

Example 2: Calculate the mid-year population of 1985 from the data given in the previous example.

Let r be the rate of increase of population per person per year.

$$\text{Then } 2,80,000 = 2,10,000 (1+r)^{10}$$

$$r = 0.029186$$

Now mid-year-population in 1985 = $2,80,000 (1+r)^{4\frac{1}{3}}$

$$= 2,80,000(1.029186)^{13/3} = 3,17,174$$

This is certainly a better method.

POPULATION DENSITY

This is measured in terms of the number of people per square km in a particular year. The population density in India was 324 in 2001.

POPULATION PYRAMID

The age and sex distribution of population can be shown by a diagram, called population pyramid (**Figs 25.5 and 25.6**). It is a broad based conical pyramid because of high birth rate and tapering of population with increase in age. In countries with low birth rate, the pyramid swells in the middle, is narrow at the base, and is not so conical at the top (dumb bell shaped "pyramid").

RATES AND RATIOS

The rates are usually calculated from the total events occurring in a geographical area over a period of a calendar year. They are hence annual rates and are of two types, crude and specific: Crude rate is based on total population while a specific rate is based on the population group specified on the basis of age, sex, occupation, etc.

$$\text{Crude rate per thousand} = \frac{\text{Total number of events that occurred in a given geographical area during a given period}}{\text{Mid-year population}} \times 1000$$

$$\text{Specific rate per thousand} = \frac{\text{No. of events which occurred among a specific group of the population of a given geographical area during a given period}}{\text{Mid-period population of the specified group in the given geographical area during the same period}} \times 1000$$

Various rates and ratios related to birth, fertility, marriage, morbidity and death are described below.

Birth Rates

$$\text{Crude birth rate} = \frac{\text{Number of live births which occurred in the population of a given geographical area during a given year}}{\text{Mid-year total population of the given geographic area during the same year}} \times 1000$$

The number of live births is distinct from the number of total births, which includes stillbirths also. This is a crude rate, calculated on the basis of whole population while, in reality, only women between 15 and 44 years of age are exposed to natality.

Example 3: The mid-year population in a town was 5,00,000 and the number of live births during the year was 20,000. Find the crude birth rate.

$$\text{Crude birth rate} = \frac{20,000}{5,00,000} \times 1000 = 40$$

Birth rate is useful to find the natural increase or growth rate in a population.

Example 4: Birth rate in India in 1987 was 32 and death rate was 10.8/1000 population. Find the natural increase.

$$\text{Natural increase} = 32 - 10.8 = 21.2 \text{ per thousand or } 2.12\%$$

Fertility Rates

The definitions of various rates are given below.¹¹ The respective values are given in **Table 25.7**. The age of fertility is generally taken as 15 to 49 years. However, some people prefer to regard the fertile period as 15 to 45 years.¹²

General fertility rate (GFR): Number of live births per 1000 women in the reproductive age group (15-49 years) in a given year.

General marital fertility rate (GMFR): Number of live births per 1000 married women in the reproductive age-group (15-49 years) in a given year.

Total fertility rate (TFR): Average number of children that would be born to a woman if she experiences the current fertility pattern throughout her reproductive span (15-49 years).

Total marital fertility rate (TMFR): Average number of children that would be born to a married woman if she experiences the current fertility pattern throughout her reproductive span, i.e. 15 to 49 years. (The TFR serves an estimate of the average number of children per family).

Gross reproduction rate (GRR): Average number of daughters that would be born to a woman if she experiences the current fertility pattern throughout her reproductive span (15-49 years).

Net production rate (NR): Average number of daughters that would be born to a woman if she experiences the current fertility and mortality patterns throughout her reproductive span (15-49 years).

Age-specific fertility rate: Number of live births in a year to 1000 women in any specified age group.

Age-specific marital fertility rate: Number of live births in a year to 1000 married women in any specified age group.

Cumulative % fertility: The ratio of the age-specific fertility rate to total fertility rate multiplied by 100.

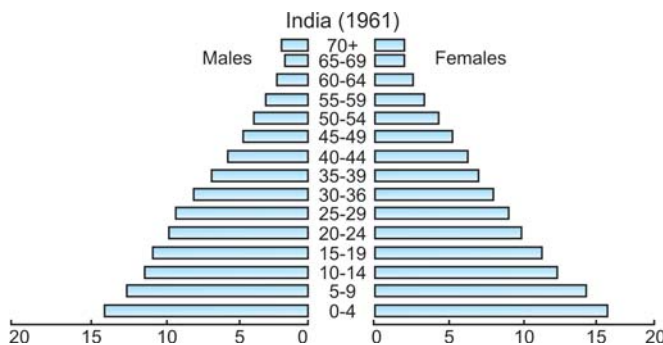


Fig. 25.5: Population pyramid

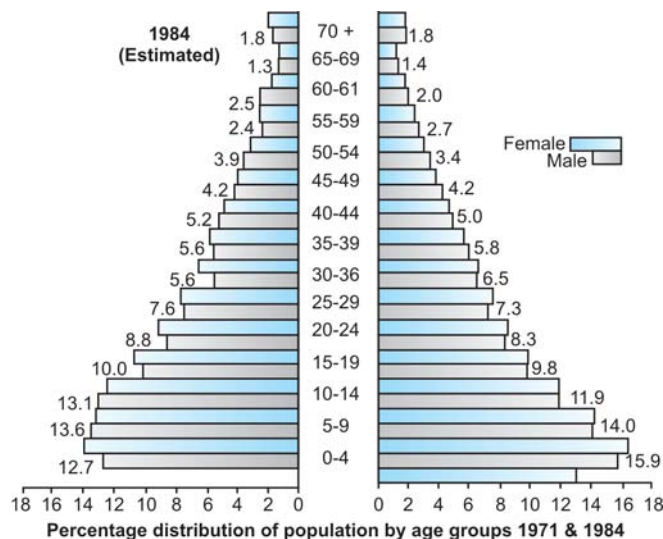


Fig. 25.6: Age, sex distribution of population of 1971 and 1981

Total fertility rate (TFR): It is derived by adding the yearly age specific fertility rates during the age 15 to 49 years. The TFR thus gives an estimate of the average total number of children that may be born to a woman if she passes through her entire period of fertility, experiencing the age specific fertility rates currently prevalent in the community. Since the age specific fertility rates are usually given for 5 year age intervals, the rates for an interval have to be multiplied by 6. This calculation is clarified in **Table 25.8**.

Since all women aged 15 to 49 years are not equally exposed to the possibility of childbirth, the TFR is a more sensitive index of fertility than GFR. It may be noted that while GFR is expressed as the number of children born to a thousand women per year, the TFR is expressed as the number of children estimated to be born to one woman throughout her reproductive period. In other words, while GFR reflects births per 1000 women per year, TFR reflects births per woman through life-time.

Current Estimates of TFR (2009)⁸

- TFR for the country remained stationery at 2.6 during 2008 to 2009.
- Bihar reported the highest TFR (3.9) while Kerala and Tamil Nadu, the lowest (1.7).
- Replacement level TFR, viz 2.1, has been attained by Andhra Pradesh (1.9), Delhi (1.9), Himachal Pradesh (1.9), Karnataka (2.0), Kerala (1.7),

Maharashtra (1.9), Punjab (1.9), Tamil Nadu (1.7) and West Bengal (1.9).

- At present, a rural woman (having a TFR of 2.9) at the National level would have about one child more than an urban woman (having a TFR of 2.0).
- Another 10 to 12 years are required to achieve the replacement level of 2.1 at the current fertility rates.

Fecundity: Fertility should not be confused with fecundity which refers to the child bearing capacity of a woman.

Total fecundity is defined as the resultant fertility if a woman, throughout her reproductive period, remained married, did not use contraception or abortion and did not breastfeed her children. World estimates of total fecundity vary from 13 to 17, the average being 15.3. The figure for India has been estimated to be 13.5. The reasons for the low fecundity of Indian women are sociocultural (leading to several days of abstinence in wedlock) and biological (early menopause, higher sterility).

Marriage Rates

$$\text{Crude marriage rate} = \frac{\text{Total no. of marriages during a calendar year}}{\text{Total mid-year population}} \times 1000$$

$$\text{General marriage rate} = \frac{\text{Total no. of marriages during the year}}{\text{Total no. of unmarried persons aged 15-49 years}} \times 1000$$

TABLE 25.7: Fertility indicators in India¹²

	Rural			Urban		
	1972	1978	1986	1972	1978	1986
General fertility rate (GFR)	165.6	146.8	145.6	139.8	111.6	108.1
General marital fertility rate (GMFR)	190.8	170.2	182.8	172.9	143.6	150.6
Total fertility rate (TFR)	5.4	4.8	4.5	4.3	3.4	3.1
Total marital fertility rate (TMFR)	6.8	5.4	5.7	6.0	4.6	4.9
Gross reproduction rate (GRR)	2.7	2.3	2.2	2.1	1.6	1.5

TABLE 25.8: Derivation of TFR from age specific fertility rates¹¹

Age group	Age-specific fertility rate* (rural) 1987	5-year fertility experience for one woman		TFR (sum of various values in the previous column)
15-19	97.5	0.0975 × 5	= 0.4975	4.396
20-24	262.8	0.2628 × 5	= 1.3140	
25-29	223.3	0.2233 × 5	= 1.1116	
30-34	148.4	0.1448 × 5	= 0.7420	
35-39	88.1	0.0881 × 5	= 0.4405	
40-44	40.2	0.0402 × 5	= 0.2010	
45-49	17.9	0.0179 × 5	= 0.0895	

*Per 1000 women

Morbidity Rates

Incidence: It means occurrence of new cases due to any particular disease, during a specified period of time such as week, month or year, usually a calendar year.

Prevalence: Includes both old and new cases that existed during the defined period.

Point prevalence means the number of cases existing at a particular point of time, say on 30th May, 1990. **Period prevalence** means all these cases plus the new cases that occur during the period of the survey which may be, for example, a month or a year.

Morbidity rates may be calculated per 1000, 10,000, 1,00,000 or 1000,000 depending on the morbidity load in the community. In developing countries the rates are generally expressed as per 1000. The denominator is the mid-year population.

Incidence rates are usually calculated for acute infectious diseases, such as cholera and measles while prevalence rates are determined for chronic diseases such as leprosy, tuberculosis and filaria.

Example 5: If the number of cases of cholera occurring in a population of 5000 during the months of June and July was 40 and 80 respectively, compare the incidence of the two months.

$$\text{Incidence rate in June} = \frac{40}{5,000} \times 1000 = 8 \text{ per } 1000$$

$$\text{Incidence rate in July} = \frac{80}{5,000} \times 1000 = 16 \text{ per } 1000$$

Thus, incidence of cholera in July is double of that in June.

Example 6: If 12 cases of diabetes mellitus were found in 15,000 population in a particular year, find the prevalence rate.

$$\text{Prevalence rate} = \frac{12 \times 1000}{15,000} \times 0.8 \text{ per } 1000$$

The above is an example of period prevalence.

Other measurements of morbidity which can be easily calculated are:

- Days of illness/person/year of the whole population
- Days of illness/ill person for a particular disease.

Morbidity rates not only show the distribution and extent of disease in the community but also provide important information about the underlying causes for the high prevalence.

Death Rates and Ratios

Crude death rate: It is the most commonly used vital rate to measure the decline in total population without specifying the sections of population or the underlying cause.

$$\text{Crude death rate} = \frac{\text{No. of deaths which occurred in the population of a given geographic area during a given year}}{\text{Mid-year total population of the given geographic area during the same year}} \times 1000$$

Example 7: In a town with 50,000 population, 600 deaths were recorded in 1984. Find the crude death rate.

$$\text{Crude death rate} = \frac{600}{50,000} \times 1000 = 12$$

Specific death rates: These are as follows:

$$\text{Age-specific death rate} = \frac{\text{No. of deaths in a particular age group}}{\text{Mid-year population of that age group}} \times 1000$$

Age-specific death rate is high among the infants and the very old and is lowest in the age group 10-19. Death rate under one year of age, popularly known as infant mortality rate, is a very sensitive index of health and socioeconomic advancement in a country.

$$\text{Infant mortality rate (IMR)} = \frac{\text{No. of children dying under one year of age}}{\text{Total no. of live births}} \times 1000$$

The denominator used is the number of live births rather than the total mid-year population of children under one year of age because it is difficult to estimate the latter due to under registration of births. Deaths under one year are classified further as:

$$\text{Neonatal mortality rate} = \frac{\text{No. of deaths under 28 days of age}}{\text{No. of live births}} \times 1000$$

$$\text{Fetal death ratio} = \frac{\text{Fetal deaths}}{\text{Live births}} \times 100$$

$$\text{Stillbirth rate} = \frac{\text{Fetal deaths after 28 weeks of gestation}}{\text{Live births}} \times 1000$$

- **Perinatal mortality rate**—It includes:
 - Fetal deaths after 28 days of gestation, when the fetus becomes viable (or fetal deaths when the fetus weighs more than 1000 gm)
 - Deaths during labor
 - Deaths within seven days of neonatal life.

$$\text{Post-neonatal mortality or late infants mortality rate} = \frac{\text{Deaths of infants aged 28 days under one year}}{\text{Live births}} \times 1000$$

- **Under five mortality rate or U5MR** is the annual number of deaths of children under five years of age per 1000 live births. More specifically, this is the probability of dying between birth and exactly five years of age.¹

$$\text{U5MR} = \frac{\text{Deaths under exactly 5 years age}}{\text{Live births}} \times 1000$$

$$\text{Child survival index} = \frac{1000 - \text{U5MR}}{10}$$

- **Sex-specific deaths rate**

$$\text{Male death rate} = \frac{\text{Male deaths}}{\text{Mid-year population of males}} \times 1000$$

It may be mentioned that death rate in India is higher in females compared to males from infancy upto 34 years of age, after which there is a reversal. The higher females mortality during this period may be attributable to neglect of females children (up to 15 years of age) and higher maternal mortality thereafter during the highly fertile period of 15-34 years.

$$\bullet \text{ Age-sex specific death rate} = \frac{\text{Female deaths at specified age, say 15-49}}{\text{Female population aged 15-49}} \times 1000$$

An important rate applicable to deaths in mothers owing to puerperal or maternal causes is specifically known as maternal mortality rate. In this, the population exposed to the risk consists only of those women who become pregnant. Since this specified age, say 15 to 49 number is usually unknown, the denominator used is live births in a year.

$$\bullet \text{ Maternal mortality rate} = \frac{\text{No. of deaths due to puerperal causes in females during a year}}{\text{No. of live births during the year}} \times 1000$$

Puerperal or maternal deaths include those due to complications of pregnancy, childbirth and puerperium up to 42 days after delivery. However, the FIGO (International Federation of Gynecology and Obstetrics) *definition of maternal mortality rate* is the number of women dying from any cause while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of pregnancy, per 100,000 live births. The MMR per 100,000 for 1972 was reported as 10 in Denmark, 8 in USA, 410 in India and 400 in Bangladesh.¹³

Example 8: In a town with a population of 50,000, there were 2000 births and 200 infant deaths in the year 1980. Eighty infants died in the first month of life while 40 of them died in the first week of life. There were 110 stillbirths in the same year. Calculate infant mortality rate, neonatal mortality rate and perinatal and postneonatal mortality rates.

$$\text{Infant mortality rate} = \frac{200}{2000} \times 1000 = 100 \text{ per 1000}$$

$$\text{Neonatal mortality rate} = \frac{80}{2000} \times 1000 = 40 \text{ per 1000}$$

$$\text{Perinatal mortality rate} = \frac{110 + 40}{2000} \times 1000 = 75 \text{ per 1000}$$

$$\text{Postneonatal mortality rate} = \frac{200 - 80}{2000} \times 1000 = 60 \text{ per 1000}$$

- ‘Cause of specific death’ rates: Death rates for any particular disease, like TB, can be calculated by the same general formula but may be expressed per 10,000, 100,000 or 1000,000 of the population if the deaths are very few.

Age-sex cause specific death rates can be found in a similar manner.

- *Proportional mortality rate:* Here the deaths due to different causes are expressed as percentages of total deaths. The important causes of death in the community can thus be found out clearly.
- *Case fatality rate:* The word rate here is a misnomer. It is in fact the ratio of deaths due to a particular disease to the number of persons who suffered from the disease.

Example 9: If 16 out of 50 cases died in a cholera epidemic, find the case fatality rate.

$$\text{Case fatality rate} = \frac{16}{50} \times 100 = 32\%$$

Interpretation, Conclusions, and Recommendations

Biased conclusions due to defects in registration, collection, and compilation are very likely. When the records are not reliable, it is better to carry out sample surveys, following strictly the rules for selection and inquiry.

Birth and Fertility Rates

High crude birth rate and fertility rate indicate rapid increase in population, which calls for birth control measures. If the birth control measures are effective, there should be a fall in birth rate and fertility rate. There are some indices that may indicate a fall in birth rate when other vital statistics are lacking or are not reliable. These include:

- Child woman ratio = $\frac{\text{Children under 5 years}}{\text{Women aged 15-49}}$
- Percentage of births of higher order such as fourth and more. If it is low, it means family planning is effective.
- Average interval between births-longer in travel indicates fall in birth rate.
- Pregnancy rate = $\frac{\text{Pregnancies to women of childbearing age}}{\text{Total years of exposure}} \times 100$

This rate can be used to study the effectiveness of a contraceptive.

Example 10: If 100 women are married for the last 10 years and they give history of 700 pregnancies in the same period, find the pregnancy rate.

Total exposure is $100 \times 10 = 1000$ woman years

$$\text{Pregnancy rate} = \frac{700}{1000} \times 100 = 70\%$$

i.e. 70 pregnancies per 100 woman years.

Death Rates

Crude death rates can be greatly affected by age-sex distribution. Hence they should be standardized before drawing conclusions or making comparisons from place

to place. Crude death rate in a colony of retired people will be very high while in a new township developed near an oil refinery and inhabited mostly by young people, it will be very low. Standardized death rates can be calculated by two methods, direct and indirect, as described below. It should be pointed out that these methods of standardisation are not unique to death rates and can also be used for comparing other events, such as morbidity rates.

DIRECT STANDARDIZATION

In this method the age specific death rates in the community under study are applied to various age groups in the standard population. Their total gives the standardized mortality rate for the population under study. The reference population is usually the population of the whole country. This enables comparison of rates in two communities within the country. However, an international standard population has to be used for comparison of rates within countries. Such an international standard population, as suggested by the WHO,¹⁴ is given in **Table 25.9**. For comparison, the age structure of population in India is given in **Table 25.10**. The method of calculation is given in **Table 25.11**.

INDIRECT STANDARDIZATION

The direct method necessitates the knowledge of age specific death rates in the population studied before the results can be standardized. Sometimes this information may not be available. At other times, the population size may be too small, especially in certain age groups, with the result that age-specific death rates may fluctuate widely with slight variation in the number of deaths in the particular category. In such situations, the indirect method of standardisation is used. The information required for using this method is the age structure of the study population and the age specific death rates of the standard population.

The calculation is given in **Table 25.12**, involves the following steps.

- *Calculation of index rate for the community*

$$\text{Index rate} = \frac{\text{No. of deaths estimated occur in the study population using the age specific death rates of the standard population}}{\text{Population of the study area}}$$

- *Calculation of the standardizing factor*

$$\text{Standardizing factor} = \frac{\text{Overall rate for the standard population}}{\text{Index rate for the study population}}$$

TABLE 25.9: Age structure of standard population

Age (Years)	No.
< 1	2400
1-4	9600
5-14	19000
15-19	9000
20-24	8000
25-34	14000
35-44	12000
45-54	11000
55-64	8000
65 +	7000
	100000

TABLE 25.10: Age structure of population in India* (1981 and 1991 Census)¹⁵

Age (Years)	%	
	1981	1991
0-4	14.5	12.80
5-14	27.5	24.9
15-19	8.7	9.7
20-24	7.9	8.8
25-34	14.0	15.2
35-44	11.2	11.2
45-54	7.9	7.9
55-64	4.9	5.2
65+	3.5	4.3
	100	100

TABLE 25.11: Calculation of standardized death rate (direct method)

Age group	Mid-year's population (Study area)	Deaths during the year	Age-specific death rate per 1000 (Study area)	Standard population in thousands (proportionate to all India pattern)	Expected deaths in standard population
0-4	12000	120	10.0	14500	145.00
5-14	6000	20	3.7	27500	101.75
15-19	8000	25	3.1	8700	26.97
20-24	6000	25	4.1	7900	32.39
25-34	12000	40	3.3	14000	46.20
25-44	13000	75	5.8	11200	64.96
45-54	12000	150	12.5	7900	98.75
55-64	10000	200	20.0	4900	98.00
65+	6000	500	83.3	3400	283.22
All ages	85000	1155		100,000	879.34

Crude death rate = $1155 \div 85 = 13.59$ per 1000

Standard death rate = $879.3 \div 100 = 8.97$ per 1000

- Calculation of standardized rate for the study population
Standardized rate
= Observed rate \times Standardizing factor
The method of calculation is shown in **Table 25.12**.

Sex Ratio

This is the ratio of females to males. It is expressed as the number of females per 1000 males in a population. The **primary sex ratio** is the ratio at the time of conception, **secondary sex ratio** is the ratio at time of birth, and **tertiary sex ratio** is the ratio of mature organisms.¹⁶

Ordinarily speaking, sex ratio should be more than 1. This is because women have slightly longer lifespan than men. Sex ratio in developed countries is more than one, i.e. there are more women than men. The ratio in many developing countries, including India, is less than one. There are 933 females per 1000 males in India.” Sadly, the ratio has been consistently falling in India since the beginning of this century. *It is a happy indication that the current value is an improvement on the 1991 sex ratio of 923. It is obvious that women have more innate survival capacity biologically, yet they experience higher mortality because of environmental factors (mainly social environment). As per 2011 census, sex ratio in India is adverse towards women and India was the lowest amongst 10 most populous countries in the world. Russia tops the list in sex ratio (1140) followed by USA (1129). Most alarming is decrease in child sex ratio, which was 945 in 1991 census and 927 in 2001.

The sex ratio in India during last nine decades is given below:

Census year	Sex ratio
1901	972
1911	964
1921	955
1931	950
1941	945
1951	946
1961	941
1971	930
1981	934
1991	923
2001	933
2011	940

Vital Statistics as Indicators of Health

The indices of health used commonly are related to mortality and morbidity. The various indices used are described below.

Comprehensive Indicators that Measure Health

PROPORTIONAL MORTALITY

It is the proportion of the total number of deaths in persons aged 50 years and above to the total deaths. There are more old people in developed countries and a large number of deaths occur at age 50 years and above. In countries with poor health conditions and inadequate health services, mortality before 50 years is comparatively high because of preventable and controllable causes like

TABLE 25.12: Calculation of standardised death rate (indirect method)

A Age group (years)	B Mid-year population in the area studied	C Deaths during the year	D Age-specific death rates in the standard population*	E Estimated no. of deaths in the study population (B \times D)
0-14	12000	120	38.4	460.8
5-14	6000	20	2.8	16.8
15-19	8000	25	2.3	18.4
20-24	6000	25	3.1	18.6
25-34	12000	40	3.3	39.6
35-44	13000	75	4.9	63.7
45-54	12000	150	10.6	127.2
55-64	10000	200	26.1	261.0
65 +	6000	500	77.9	467.4
All ages	85000	1155		1493.5

Crude death rate (Study population) = $1155 \div 85 = 13.59$
 Crude death rate (Standard population) = 11.8**

$$\text{Index rate for study population} = \frac{1493.5}{85} = 17.57$$

$$\text{Standardizing factor} = \frac{11.8}{17.57} = 0.67$$

Standardized death rate = $13.59 \times 0.67 = 9.11$

*All India rates for 1985 (Source:¹⁵).

**All India rate for 1985 (Source:¹⁷).

malnutrition and communicable diseases. Such mortality is particularly higher in young children and women (due to high maternal mortality). High proportional mortality obviously reflects better health conditions in a community. In this index, the population data are not required and slight defects in registration do not affect the conclusion and interpretation.

CRUDE DEATH RATE

This is often the only index available. For comparison between two population, it is essential to use age adjusted or standardized death rates as described already.

EXPECTATION OF LIFE

Longevity, worked out by the Life Table Method (described below), is also a comprehensive measure of community health. It summarises the mortality experience at all ages of life. It is not affected by age and sex distribution. It is obtainable at 10 yearly intervals as per census years and measures health on a long-term basis. It is a very good index to compare the level of health in different countries. However, by the very nature of its derivation, it is not suitable for quantifying the change in the level of health in a country over a few years.

Life Table: It is a particular way of expressing the death rates experienced by a particular population during a particular period. The following information is required in order to construct a life table:

- Age-wise break-up of population in a given year
- The number of deaths that occurred at these ages.

A life table helps in answering several vital questions, such as:

- What is the number of survivors out of a cohort of 1000 at any age, say 25,56,70, etc.?
- What is the number that will die at any age, say 30, or from one age to another say 50 to 55?
- What is the average length of life expected at birth?
- What is the expectation of life at any age after birth, say at 58 or 60, i.e. on retirement?

The uses of life table include the following:

- To find the number of survivors at any age, e.g.
 - At the age of 5 to find the number of children likely to enter primary school.
 - At the age of 15 to find the number of women entering fertile period or to find the number of adolescents entering the community.
 - At the age of 18 to find the number of persons who become eligible for voting.
 - At the age of 45 to find the number of women reaching menopause.
 - At the age of 58 to find those who become eligible for pension.
- To estimate the number of policy holders or employees likely to die after getting insured or joining service. This information is helpful in proper budgeting for payment of risk-cover or pension.
- To find the expectation of life or longevity of life at birth or at any other age. Increase in longevity means reduction in mortality. Thus life table is another

method applied to compare the mortality related to two places, periods, professions or groups.

- To find the rate of survival after treatment in diseases like tuberculosis and cancer by the modified life table technique.¹⁰ The details of constructing the life table are given in books dealing with health statistics.^{10,18}

Specific Indicators that Measure Health

These include the rates for stillbirth, perinatal, neonatal, postneonatal, infant and maternal mortality, discussed already. Death rates for communicable diseases such as tuberculosis, cholera and tetanus are useful indicators of community health, though records are often incomplete and unreliable. Total death rate in the age group 1 to 5 years is also a useful indicator. Morbidity data collected in specific surveys can serve as indicators of comprehensive or specific health aspects. Nutritional status, and physical growth of children from 1 to 4 years may also help in assessment of community health.

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Health Planning, Administration and Management

It is not sufficient for a doctor working in the community to be able to treat patients or even to be able to take specific preventive measures and advise about how to promote health. As a health administrator, he should be able to understand and even formulate policies, to make plans and to implement them. Policy formulation, planning, administration and management are areas with which every public health man must be thoroughly familiar. As a matter of fact, proper planning and management are essential for achieving high standard of public health.¹ These and related aspects will be discussed in this chapter. For the sake of convenience, the subject matter will be dealt within six parts as follows:

1. Health Planning
2. Health Administration and Management
3. Government Health Organization in India
4. Health Policy
5. Population Policy
6. Health and Development.

Health Planning

Planning is defined as an organized, conscious and continual attempt to select the best available alternatives to achieve specific goals.² Since all programs and projects are ultimately derived from the overall plan, it is of utmost importance to formulate a plan systematically and methodically.

Levels of Planning

Planning can be considered at three different levels:

Levels of planning	Contents	Examples
Central level—policy planning	Overall objectives setting; situational analysis and resources to achieve national level objectives	Increase number of CHCs to 1: 100,000 by 2015; Increase no. of ANMs to 25000 by 2010, etc.
State level—strategic planning	Objectives to be based on local morbidity and mortality patterns; Provision of speci-	Prioritization of districts needing additional resources like ANMs, doctors, male health workers, transport, etc.

Contd...

Contd...

Levels of planning	Contents	Examples
District level—operational planning	Implementation of activities based on local needs; Optimal utilization of available resources	Which PHC needs additional support; which subcentre does not have an ANM posted; which villages should be visited by the male health worker on his daily beat on a particular day

Steps In Planning

Simply stated, a plan is a course of action one intends to follow in order to solve a problem. Since so many people in many different places are involved in health care delivery, one has to indicate very clearly, Who is going to do What, Where and When with regard to the defined problems and the stated objectives. Since a plan gives objectives, goals and targets, one can measure its effectiveness in reducing the problem and its efficiency in terms of costs.

Planning consists of the following steps:

- Making a plan
- Executing the plan finalized
- Controlling and supervising the working of the plan (proper implementation)
- Constantly evaluating and assessing the progress of the plan (monitoring and evaluation)
- Carrying out operational research to improve administration and planning.

Summarily stated, planning consists of plan formulation, execution and evaluation.

MAKING A PLAN

A plan is a blueprint for action. Its components are objectives, programs, schedules and budget. The word *program* means the sequence of activities designed to implement the plan and fulfill the objectives. The word *schedule*, on the other hand, refers to the time sequence for the tasks to be performed. Planning

requires the assessment of Needs and Resources, as also their proper matching, so that maximum needs may be fulfilled while utilizing minimum resources in the shortest possible time. In reference to health, the *health needs* are defined as deficiencies in health that call for preventive, curative, control or eradication measures.³ The term resources implies the money, material, manpower, knowledge, skills, techniques and time that may be needed for action directed towards specified objectives. Since the resources are usually limited, proper planning is a must. This leads to the concept of 'priorities', which signifies selection of outstanding needs and meeting them more urgently than others that may wait till resources develop or can be diverted.

Aspects to be considered while formulating a health related plan are listed below:

- Existing level of health of the community
- The reasons for the existence of such level
- The outstanding health and disease problems and their causes
- Resources in men, money and materials available for raising such level
- Priorities in terms of time and targets within the resources available
- Methods to increase resources.

In other words, the following must be done before a plan is developed:

- Understanding and analysing the situation (situational analysis)
- Selecting important problems or needs
- Formulation of operational goals (setting of objectives)
- Reviewing the obstacles and limitations.

The Bhore Committee Report⁴ is a good example of such assessment and planning.

EXECUTION OF THE PLAN

This requires the following:

- Recruitment and training of personnel to carry out the plans
- Placement of men and materials at the right time to initiate and execute the services according to the projected time schedules
- Eliciting social and public acceptance for the programs
- Providing the necessary leadership to the team of workers at all levels
- Detailed breakdown of the overall plan for execution at the local levels and in the field including the methodology of work.

The National Malaria Eradication Program is a good example of planning and execution of a health program.

CONTROL AND SUPERVISION

These include the following:

- Monetary and financial controls, e.g. budgeting

- Work schedule controls to assess individual and collective works
- Scrutinizing of reports and returns
- Medical and technical audit of health units
- Inspection and appraisal in the field.

EVALUATION

Evaluation of all programs requires an objective, thorough and independent scrutiny of their progress at the operational level to detect bottlenecks, if any. Mid term evaluation helps in executing the plan according to schedule. Evaluation is a very important process.

Requirements for proper evaluation include the following:

- Establishment of definite criteria which may be both subjective and objective but which must be capable of definite measurement
- Unbiased assessment and proper randomization of samples
- Independent appraisal (not by those executing the program).

Based upon the results of the evaluation, programs can be reoriented, bottlenecks can be removed and execution can be facilitated.

OPERATIONAL RESEARCH

It is aimed at creating a better organization, improving the methodology of execution and achieving better control and better results.

Operational research (OR) is defined as 'Any research producing practically usable knowledge (evidence, findings, information, etc.) which can improve program implementation (e.g. effectiveness, efficiency, quality, access, scale up, sustainability) regardless of the type of research (design, methodology, approach) falls within the boundaries of operational research'.⁵

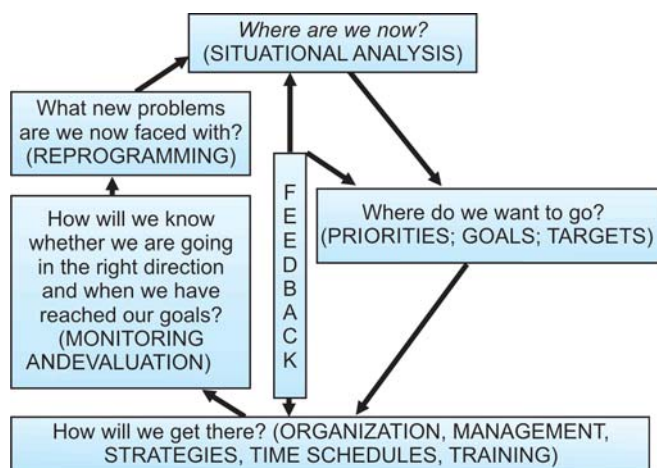
Operational research can deal with wide ranging issues in public health—health system, disease prevention, and control along with community issues. Like any other research, OR begins with identification of problems and its statement culminating to writing a good research question. The techniques that are used in quantitative and qualitative research can also be applied in OR. Monitoring and evaluation activities as part of OR (M'OR'E) have gained real importance in all national public health programmes today.⁵

Health Planning In India

PLANNING COMMISSION

It was set up in 1950 for the purpose of appropriate planning for India's development within the resources available. Five-year developmental plans were drafted

THE HEALTH PLANNING AND IMPLEMENTATION CYCLE



by the Planning Commission from 1950-51 onwards. In 1957, a Perspective Planning Division was added to the Planning Commission for futuristic planning over next 20-25 years. The three major wings of the Planning Commission are the General Secretariat, the Technical Divisions and the Program Advisers. It has a Chairman, a Deputy Chairman and eight members.

The Prime Minister is the Chairman of the Planning Commission, which works under the overall guidance of the National Development Council. The Deputy Chairman and the full-time Members of the Commission, as a composite body, provide advice and guidance. Divisions exist for the formulation of Five-year Plans, annual plans, state plans, monitoring plan programmes, projects and schemes.

Divisions

- Agriculture Division
- Backward Classes Division
- Communication and Information Division
- Development Policy Division
- Education Division
- Environment and Forest Division
- Financial Resources Division
- Health, Nutrition and Family Welfare Division
- Housing, Urban Development and Water Supply Division
- Industry and Minerals Division
- International Economic Division
- Labor, Employment and Manpower Division
- Multilevel Planning Division
- Monitoring Division
- Perspective Planning Division
- Plan Coordination Division
- Power and Energy Division
- Program Evaluation Organization
- Project Appraisal and Management Division
- Rural Development Division
- Science and Technology Division
- Social Development and Women's Program Division

- Social Welfare Division
- State Plans Division
- Transport Division
- Village and Small Industries Division
- Water Resources Division
- Administration and Services Division
- Other Units—Border Area Development Programs; Socioeconomic Research Unit.

From a highly centralized planning system, the Indian economy is gradually moving towards indicative planning where Planning Commission concerns itself with the building of a long-term strategic vision of the future and decide on priorities of nation. It works out sectoral targets and provides promotional stimulus to the economy to grow in the desired direction.

Planning Commission plays an integrative role in the development of a holistic approach to the policy formulation in critical areas of human and economic development. In the social sector, schemes which require coordination and synthesis like rural health, drinking water, rural energy needs, literacy and environment protection have yet to be subjected to coordinated policy formulation. It has led to multiplicity of agencies. An integrated approach can lead to better results at much lower costs.

NATIONAL HEALTH PLANNING

It has been defined as “the orderly process of defining community health problems, identifying unmet needs and surveying the resources to meet them, establishing priority goals that are realistic and feasible and projecting administrative action to accomplish the purpose of the proposed program. India resorted to health planning soon after independence, when the first five years plan was initiated in 1951. Health and Family Welfare Division consists of:

- Health Care for Women and Children
- Implementation of Population Policy and rapid population stabilization
- Improving micronutrient nutritional status of the population
- Development of Human Resources for Health
- Communicable Diseases
- Health Economics
- Health Cares Services
- Health Education and IEC
- Indian Systems of Medicine and Homoeopathy
- Health Systems Research and Biomedical Research and Development
- Noncommunicable Diseases
- Environment and Occupational Health
- Improving nutritional status of population with special focus on Vulnerable Groups

In addition to the Five-Year Plans and Programs, in 1975, the Government of India initiated a special activity. This was the 20-point program—described as

an agenda for national action to promote social justice and economic growth.

On August 20, 1986, the existing 20-Point Program was restructured. Its objectives are spelt out by the Government as “eradication of poverty, raising productivity, reducing inequalities, removing social and economic disparities and improving the quality of life.

At least 8 of the 20 points are related, directly or indirectly, to health. These are:

1. Attack on rural poverty
2. Clean drinking water
3. Health for all
4. Two child norm
5. Expansion of education
6. Housing for the people
7. Improvement of slums
8. Protection of the environment.

The restructured 20-point program constitutes the charter for the country’s socioeconomic development. It has been described as the cutting edge of the plan for the poor.

National Health Planning is an integral part of general social and economic planning. Planning should be done in accordance with national health policies which are formulated in accordance with the general developmental policies of the government. The conditions desirable for planning include:

- Laws and regulations to facilitate planning
- A planning organization for overall socioeconomic planning at policy level
- Administrative capacity essential for planning.

A National Health Plan is based on adequate information. Basic information required for Health Planning Programming is generated from Policy data, Demographic data, Economic data, Health status data, Environmental health data, Data on health service resources and facilities, Health manpower data and Unit cost data.

The financial outlays on ‘Health’ during the various Plan periods are given in **Table 26.1**. Health being a state subject according to the constitution, the expansion

of health services depends upon the states and their resources. The health expenditure in various States is given in **Table 26.2**.

NINTH PLAN: HEALTH AND FAMILY WELFARE

During the Ninth Plan there is an absolute and total commitment to:

- Improving access to and enhance quality of primary health care in urban and rural areas through an optimally functioning primary health care system
- Appropriate strengthening of the secondary and tertiary care institutions
- Improving efficiency and build up effective referral linkages between existing primary, secondary and tertiary care institutions
- Development of human resources for health, adequate in quantity, appropriate in quality, with proper programme and people orientation
- Effective implementation of the provisions of food and drug safety
- Enhancing research capabilities and strengthen basic, clinical and health systems research.

Minimum Needs Program

The Minimum Needs Program (MNP) was launched in the Fifth Five-Year Plan. Its objective was to ensure a basic minimum standard of life for all sections of people living in the rural areas of the country. The strategy was to establish a network of facilities to attain an acceptable level of social consumption in respect of selected items within a stipulated time-frame. The rationale was two-fold. First, it was felt that the competing demands for greater investment in other development sectors left relatively small allocations for social services. In the face of resource constraint, the tendency was to impose economy measures or cuts in the allocations for social sectors. Second, there were wide inter-state differences in the provision of social services and infrastructure which called for governmental intervention.

TABLE 26.1: Health related investment pattern in various five-year plans (in crores of rupees)⁶

Plan	Years	Health	Family welfare	3 + 4	Water supply and sanitation	Total plan expenditure	5 as % of 7	5 + 6 as % of 7
1	2	3	4	5	6	7	8	9
I	1951-56	65.2	0.1	65.3	11.0	1960.0	3.3	3.9
II	1956-61	140.8	2.2	143.0	74.0	4672.0	3.1	4.7
III	1961-66	225.9	24.9	250.8	110.2	8576.5	2.9	4.2
IV	1969-74	335.5	278.0	613.5	548.0	15778.8	3.9	7.4
V	1974-79	760.8	491.8	1252.6	1107.5	39426.2	3.2	5.99
VI	1980-85	2052.2	1387.0	3412.2	3996.9	109291.7	3.1	6.7
VII	1985-90	3688.6	3120.8	6809.4	7093.1	218729.6	3.1	6.4
VIII	1992-97	7575.9	6500.0	14075.9	2514.4	798000.0	1.76	6.2
IX	1997-2002	5118.2	15120.2	20238.4	39538.0	859200.0	2.35	4.6

Note:

- In addition to the above, the Planning Commission made a special allocation of Rs.1740.2 crores for nutrition in the VII Plan (Rs. 238.1 crores in the VI Plan).
- The periods 1966-69, 1979-80 and 1990-92 were covered by Annual Plans

TABLE 26.2: Per capita public health care expenditure

States	Male		Female	
	1996-2001	2001-2006	1996-2001	2001-2006
AP	61.55	62.79	63.74	65
Assam	57.34	58.96	58.84	60.87
Bihar	63.55	65.66	62.07	64.79
Gujarat	61.53	63.12	62.77	64.10
Haryana	63.87	64.64	67.39	69.30
Karnataka	61.73	63.43	65.36	66.44
Kerala	70.69	71.69	75	75
MP	56.83	59.19	57.21	58.01
Maharashtra	65.31	66.75	68.19	69.76
Orissa	58.52	60.05	58.07	59.71
Punjab	68.39	69.78	71.40	72
Rajasthan	60.32	62.17	61.36	62.80
Tamil Nadu	65.21	67	67.58	69.75
UP	61.20	63.54	61.10	64.09
West Bengal	64.50	66.08	67.20	69.34
India	62.30	63.87	65.27	66.91

(Source: Registrar General of India 1996: Population Projections for India and States - 1996-2016)⁷

Initially, there were eight components of MNP, viz. elementary education, rural health, rural water supply, rural electrification, rural roads, rural housing, environmental improvement of urban slums and nutrition. While adult education was added to the list of MNP components in the Sixth Plan, rural domestic energy, rural sanitation and public distribution system were added during the Seventh Plan.

Recognizing the shortfall in the achievement of the basic minimum standard of life for all sections of the people, a bold initiative was taken by the Chief Ministers Conference held in July, 1996 to ensure access of all to certain Basic Minimum Services (BMS) in a time-bound manner.

The Conference endorsed the seven basic minimum services as of paramount importance in securing a better quality of life for the people, especially those residing in rural areas. Further, it observed that it would be in the best interests of the country, if time-bound action plans are formulated to secure full coverage of the country with these seven basic services by 2000 AD. This was essential for the rapid growth of the economy and for social justice and hence, these basic services were to constitute the core of the social sector development plan.

The seven basic services identified for priority attention are:

1. 100 percent coverage of provision of safe drinking water in rural and urban areas
2. 100 percent coverage of primary health service facilities in rural and urban areas
3. Universalization of primary education
4. Provision of Public Housing Assistance to all shelterless poor families
5. Extension of Mid-day Meal Program in primary schools, to all rural blocks and urban slums and disadvantaged sections
6. Provision of connectivity to all unconnected villages and habitations

7. Streamlining of the Public Distribution System with focus upon the poor.

Salient Features of Basic Minimum Needs Program

Objective is to ensure access of all the people living in both rural and urban areas to the seven basic services in a time-bound manner.

The provision of funds for items covered under the BMS are primarily part of the Plan of a State/UT, and are earmarked so that no diversion is possible. In addition, Centrally Sponsored Schemes were introduced in order to provide additional resources to supplement the resources of the States in some critical areas, e.g. the scheme of Operation Black Board in the education sector and the Accelerated Rural Water Supply Scheme for drinking water in rural areas.

Primary Health Facilities

The primary health care infrastructure provides the integrated promotive, preventive, curative and rehabilitative services to the population close to their residence. It is estimated that over 80 percent of the health care needs of the population can be met by the primary health care infrastructure; only the rest may require referral to the secondary or tertiary health care institutions.

Rural Primary Health Care: During the Sixth Plan, the national norms for a three tier rural primary health care infrastructure consisting of the Subcenter (SC), Primary Health Center (PHC) and the Community Health Center (CHC) were evolved. While the Sixth and the Seventh Plan witnessed major expansion of the rural health care infrastructure, the Eighth Plan concentrated the efforts on development, consolidation and strengthening of the existing health care infrastructure to bring about improvement in quality and outreach of services. The national norm for a Subcentre varies between 3000 and 5000 population depending upon terrain and location; on similar considerations the norm for a Primary Health Center is 20,000 to 30,000 population; for four PHCs there should be a Community Health Center.

Urban Primary Health Care: Nearly 30 percent of India's population live in urban areas. Due to urban migration and massive inflow of population to the towns and cities, the health status of urban slum dwellers is at times worse than the rural population. There has not been any well planned and organized efforts to provide primary health care services to the population within 2 to 3 km of their residence and to link primary, secondary and tertiary care institutions in geographically defined areas. As a result there is either a nonavailability or at times under-utilization of available primary health care facilities and consequent overcrowding at the secondary and tertiary care centers.

The NDC endorsed the approach paper to the Ninth Plan emphasizing the need to create a well-structured organization of urban primary health care aimed at providing basic health and family welfare services to the population within one-two kilometers of their dwellings.

Primary health care infrastructure in urban areas should consist of health and family welfare posts to cover 10,000 to 15,000 population manned by an ANM and one male multipurpose worker with a helper. Urban health and family welfare center should cater to about 1 to 1.5 lakh population. These centers should be provided with two Medical Officers and other required supporting staff; they will provide preventive, promotive, curative and rehabilitative services and essential maternal, child health and contraceptive care.

In order to cover the urban population especially the slum dwellers effectively it may be necessary to redeploy the personnel in the existing centers, strengthen the centers with appropriate manpower besides providing essential equipment, mobility and drugs.

Universalization of Primary Education

In order to achieve universalization of primary education (UPE), it had been estimated for the year 1993-94 that approximately 142 million children in the age-group 6 to 11 years would have to be provided primary schooling out of which 69 million would be girls.

Apart from availability or access to primary school within a walking distance of habitations, there are a number of other problems which are required to be tackled on an urgent basis. Some of these are low enrollment of girls, high dropout rates, education of disadvantaged groups, lack of physical infrastructure like school buildings, teachers, teaching-learning equipment and the problem of working children, low levels of achievement and regional disparities.

In pursuance of the adoption of the National Policy on Education (NPE), 1986, the Scheme of Operation Blackboard (OB) was introduced as a Centrally Sponsored Scheme (CSS) to provide certain minimum facilities in the primary schools in order to increase enrolment and reduce dropout. The OB norms aimed at providing at least one additional teacher preferably a female teacher, in single teacher schools, at least two reasonably large all weather classrooms for every school and a set of teaching-learning equipment.

In order to address the needs of the dropouts and the working children, the Nonformal Education (NFE) scheme is being implemented.

The District Primary Education Program (DPEP) aims at providing access to primary education for all children, reducing dropout rates to less than 10 percent, increasing the learning achievement of primary school students by at least 20 percent and reducing the gap

among gender and social groups to less than 5 percent in the educationally backward districts with female literacy below the national average and districts where the Total Literacy Campaign (TLC) have been successful leading to enhanced demand for primary education. The DPEP needs to be implemented vigorously.

Safe Drinking Water for All

The existing norms for rural water supply is 40 liters per capita per day (LPCD) of drinking water and a public standpost or a handpump for 250 persons. Further, the sources of water supply should be within 1.6 km horizontal distance in plains or 100 meters elevation distance in hills. Against this, the norm for urban water supply is 125 LPCD piped water supply with sewerage system, 70 LPCD without sewerage system and 40 LPCD in towns with spot sources. At least one source for 20 families within a maximum distance of 100 metres has been laid down.

Apart from the provision in the state plans for water supply, there are major Centrally Sponsored Schemes called the Accelerated Rural Water Supply Program and the Urban Water Supply Program for small towns with population of less than 20,000.

Nutrition

There are two major programs which provide food supplements to the vulnerable segments of the population; these are the Special Nutrition Program (SNP) and the Mid-day Meal Program (MDMP).

Special Nutrition Program is one of the important components of the Integrated Child Development Services Program. The target group receiving food supplementation are children between the age of 6 months to 6 years and pregnant and lactating mothers. Efforts are made to provide 300 calories and 10 grams of proteins per child, 500 calories and 15 to 20 grams of proteins for pregnant/nursing women and 600 calories and 20 grams of proteins to severely malnourished children as food supplements at prevailing prices. The beneficiaries receive the supplements through ICDS infrastructure which is funded by the Dept of Women and Child Development. The cost of food supplements is met by the State Governments and UTs through the State Plan Budget.

The Program of Nutritional Support to Primary Education, popularly known as the Mid-day Meal Scheme, was launched in 1995 as a fully funded Centrally Sponsored Scheme. Under this scheme, all school children in the primary schools in government and government-aided schools are to be covered. Ideally, a hot meal is provided to the children at school but for 10 months in a year. The foodgrains are delivered directly at the district level by the Food Corporation of India under instructions from the Department of Education in the Government of India.

Housing

The Centrally Sponsored Scheme for providing shelter to the shelterless poor is called the Indira Awaas Yojana, wherein free houses are distributed to targetted beneficiaries belonging to the poor segments, specially those who belong to SCs/ STs or freed bonded labor. Under this program the center provides 80 percent of the funds and the States the remaining 20 percent.

URBAN HEALTH CARE SERVICES

Primary Health Care

Realizing the need to provide primary health care services to the growing urban population, the municipalities, State Governments and the Central Government have tried to provide funds for building up urban primary health care. Unlike the rural health services, there have not been any well-planned and organized efforts to provide primary, secondary and tertiary care services in geographically delineated urban areas. As a result, there is either nonavailability or substantial under utilization of available primary care facilities along with an over-crowding at secondary and tertiary care centers. Re-organization of urban primary health care services to provide basic health and family welfare services to the population within 1 to 3 km of their dwellings and establishing appropriate linkages between primary, secondary and tertiary care centers in the area so that optimal utilization of the available health care facilities for referral services are ensured is one of the priority areas identified during the Ninth Plan. The Planning Commission had provided Additional Central Assistance to NCT of Delhi and to Punjab to develop models for provision of urban primary health care facilities and establish linkages with secondary and tertiary levels of care. Earmarked funds under BMS and the ACA for BMS, funds from the urban RCH project and from urban component of India Population Project (IPP) can be utilized for the development of this essential urban basic service.

Secondary Health Care

The secondary health care infrastructure at the district hospitals and urban hospitals are currently taking care of the primary health care needs of the population in the city/town in which it is located and as secondary care centers; this inevitably leads to overcrowding and under-utilization of the specialised services. To remedy the situation, four States—Andhra Pradesh, Karnataka, West Bengal and Punjab have initiated Secondary Health System Development Projects with special focus on strengthening the CHCs, District Hospital and the referral linkages between these. Orissa is also expected to initiate a similar program. This is expected to reduce the burden on the tertiary care hospitals, besides

providing a credible and effective linkage between secondary and Primary Health Care Institutions.

Tertiary Health Care

Along with the emphasis on enhancing the outreach and quality of primary health care service and the strengthening of linkages with secondary care institutions, there is a need to optimize the facilities available in the tertiary care centers. Majority of the tertiary care institutions in the governmental sector lack adequate manpower and facilities to meet the rapidly growing demand for increasingly complex diagnostic and therapeutic modalities. Over the last two decades the; institutions have been facing an increasing resource crunch and have not been able to obtain spares for equipment maintenance, to replace obsolete equipment, to maintain supply consumables and to take up necessary upgradation of the infrastructure to provide high technology, high quality care at an affordable cost to meet the ever increasing needs and rising expectations of the population. Several States have started levying user charges for the diagnosis and curative services offered in these institutions from people above the poverty line, to meet some of the recurring costs in providing such services.

DEVELOPMENT OF HUMAN RESOURCES FOR HEALTH

Health Manpower Production

India produces over 15,000 medical graduates annually; two-thirds of them go in for postgraduate training. The existing facilities for training of medical graduates have outstripped the needs. In view of this the Medical Council Act was amended in 1993 to ensure that “no person shall establish a medical college and no medical college shall open a new or a higher course of study or training including a postgraduate course of study or training or increase in its admission capacity in any course of study or training, without the prior permission of the Central Government”.

It is well recognized that there is dearth of paraprofessional personnel. Paraprofessionals are trained in three categories of training institutions: existing Govt institutions, private institutions and as a part of the 10 + 2 vocational training. There is an urgent need to ensure uniformity in training curriculum and improvement in quality of paraprofessional training. In view of the substantial difference between districts in terms of paraprofessional manpower required there is a need to access paraprofessionals required in each district and take steps appropriately for training them.

Continuing Education for Health Professionals

Continuing education to update the knowledge and skills of all health professionals is important in the context of

evolving technology, demographic transition, changing lifestyles and disease patterns. Currently Continuing Medical Education (CME) to physicians is provided through in-service training programs in various institutions. National Academy of Medical Sciences, National Board of Examinations and various professional bodies and associations. In addition, major disease control and family welfare program undertake skill upgradation and program orientation training of physicians and paraprofessionals.

Control of Communicable Diseases

Even though health is a State subject the Central Government has over the last forty years provided additional funds through Centrally Sponsored Schemes (CSS) for control of some of the major communicable diseases. These disease control programs are continuing in the Ninth Plan period. External assistance has been obtained to augment available national funds for implementing these programs.

Control of Noncommunicable Diseases

Soon after Independence, the focus of the health sector program of the Government was on control of communicable diseases. However, the programs (either Central Sector or Centrally Sponsored) for control of some noncommunicable diseases which were perceived as public health problems were also initiated. The National Goitre Control Program initiated in 1962 is the oldest Central Sector Scheme for control of noncommunicable diseases (NCD). The National Blindness Control Program the first CSS was initiated in 1976. Subsequently, several Central Sector Schemes for control of noncommunicable diseases, including the following were taken up:

- National Cancer Control Program
- Program against micronutrient malnutrition
- National Mental Health program
- Diabetes Control Program
- Cardiovascular Disease Control Program
- Prevention of Deafness and Hearing Impairment
- Oral Health programme
- Medical Rehabilitation.

In addition, some of the State Governments have initiated pilot projects for district based integrated non-communicable disease control in some districts.

Integrated Noncommunicable Disease Control Program

Accelerated economic growth in the nineties does not necessarily imply improvement in health status. Increasing longevity, demographic transition resulting in rapidly rising numbers of aged population, urbanization, increasing pollution, change from traditional diets, sedentary lifestyle and increase in the stress of day-to-day living have led to an increase in lifestyle-related disorders and noncommunicable diseases. The ongoing change in disease burden is producing a major health

transition; over the next two decades, noncommunicable diseases are likely to contribute significantly to the total disease burden in the country. Cardio and cerebrovascular diseases, diabetes mellitus and malignancies are emerging as major public health problems in the country. It is essential that preventive, promotive, curative and rehabilitative services for NCD are made available throughout the country at primary, secondary and tertiary care levels so as to reduce the morbidity and mortality associated with NCD. However, vertical programmes to control individual noncommunicable diseases would neither be feasible nor cost-effective.

Pilot projects for district-based integrated non-communicable disease control programs carried out through the existing primary and secondary level facilities, using diabetes as a model, were initiated in the Eighth Plan. Therefore, during the Ninth Plan period an integrated noncommunicable disease control programs at primary and secondary care level will be developed and implemented with emphasis on prevention of NCD, early diagnosis, management and building up of suitable referral system. Tertiary care centers will be strengthened so that treatment facilities for complications will improve. As the anticipated increase in prevalence of NCD over the next few decades is at least in parts due to changing lifestyles, it is imperative that health education for primary and secondary prevention as well as early diagnosis and prompt treatment of NCD receive the attention that it deserves. The increasingly literate population can then be expected to take a proactive role and reduce morbidity and mortality due to NCD. Mobilizing community action through well-structured IEC system including mass media will form an important intervention strategy for the control of NCD. Development of appropriate learning resource materials for education and training of manpower will be an essential activity.

Performance of the Family Welfare Program

The performance of the Family Welfare Program during the last few years is summarised in the figures given below. Acceptors of sterilization and IUD have declined during 1998-99 as compared to the year 1997-98. Conventional Contraceptive (CC) users and Oral Contraceptive (OC) users have almost remained stagnant at the level of 1998-99. However, the acceptors of different methods of family planning during the year 1998-99 are still less than the peak level observed during 1994-95. In 1996-97, the Department of Family Welfare abolished the system of centrally determined method specific targets for Family Planning. The States were requested to undertake a PHC based needs assessment and attempt to meet all the felt needs for contraception. Comparison of performance between the periods before and after abolition of method specific targets indicate that at the National level there had been a

reduction in the acceptance of different methods of contraception. Efforts to gear up the system and minimize the time lag in adaptation to decentralized planning and implementation are underway and need to be further intensified.

Performance in States with Poor Health Indices:

There are substantial differences in performance between States. The performance of the four demographically poor states is shown in the given figures. In UP there has been a decline in the number of sterilizations but Rajasthan has shown an increase in the number of acceptors of terminal methods. The acceptors of spacing methods have also increased in the state of Rajasthan; remained almost at the same level in Bihar and marginally declined in MP and UP in 1998-99 as compared to the previous year.

It is noteworthy that these four states have the largest proportion of unmet needs for family planning, both for terminal and spacing methods: This unmet need has to be met by improving availability, access and quality of care of family welfare services.

Containment of population growth is not merely a function of couple protection or contraception but is directly correlated with female literacy, age at marriage of the girls, status of women in the community, IMR, quality and outreach of health and family planning services and other socioeconomic parameters. This is illustrated in **Table 26.3**.

INDIAN SYSTEMS OF MEDICINE AND HOMEOPATHY

The Indian Systems of Medicine and Homeopathy consist of Ayurveda, Siddha, Unani and Homeopathy, and therapies such as Yoga and Naturopathy. Some of these systems are indigenous and others have over the years become a part of Indian tradition. It is estimated that there are over 6 Indian Systems of Medicine and Homeopathy.

Draft Approach Paper to the Tenth Five-year Plan (2002-2007)

Relevant portions from this document are reproduced below:⁸

Chapter 1: Objectives, Targets and Strategy

INTRODUCTION

The Tenth Five-year Plan (2002-07) is being prepared against a backdrop of high expectations arising from some aspects of the recent performance. GDP growth in the postreforms period has improved from an average of about 5.7 percent in the 1980s to an average of about 6.5 percent in the Eighth and Ninth Plan periods, making India one of the ten fastest growing developing countries. Encouraging progress has also been made in other dimensions. The percentage of the population in poverty has continued to decline, even if not as much as was targeted. Population growth has decelerated below 2 percent for the first time in four decades. Literacy has increased from 52 percent in 1991 to 65 percent in 2001 and the improvement is evident in all States. Sectors such as software services and IT enabled services have emerged as new sources of strength creating confidence about India's potential to be competitive in the world economy.

OBJECTIVES OF THE TENTH PLAN

Traditionally, the level of per capita income has been regarded as a summary indicator of the economic well being of the country and growth targets have therefore focused on growth in per capita income or per capita GDP. In the past, our growth rates of GDP have been such as to double our per capita income over a period of 20 years or so. Recognizing the importance of making a quantum jump compared with past performance, the Prime Minister has directed the Planning Commission to examine the feasibility of doubling per capita income

TABLE 26.3: Population growth and selected indicators

States	CBR (1999)	IMR (1998)	Female literacy rate (2001)	Population% below poverty line (1993-94)	Female Mean age at marriage	Female Median age at marriage (1998-99)	Median age at first cohabitation with husband (1998-99)
	(1)	(1)	(2)	(3)	(4)	(5)	(5)
Bihar	31.1	67	33.57	54.96	18.6	14.9	16.6
Kerala	18.2	16	87.86	25.43	22.3	20.2	20.3
MP	30.6	97	50.28	42.52	18.8	14.7	16.0
Maharashtra	22.3	49	67.51	36.56	19.1	16.4	16.7
Rajasthan	31.5	83	44.34	27.41	18.4	15.1	16.4
Tamil Nadu	18.9	53	64.55	35.03	20.2	18.7	18.8
UP	32.4	85	42.98	40.85	19.5	15.0	16.3
India	26.1	72	54.28	36.00	19.4	16.4	17.0

1. Annual Report, Ministry of Health and Family Welfare
3. Planning Commission IX Plan Volume 1; 1996
5. National Family Health Survey-II; 1998-99.

2. Census of India; Registrar General of India, 2001.
4. SRS, 1994

in the next ten years. With population expected to grow at about 1.6 percent per annum, this target requires the rate of growth of GDP to be around 8.7 percent over the Tenth and Eleventh Plan periods.

MONITORABLE TARGETS FOR THE TENTH PLAN AND BEYOND

- Reduction of poverty ratio to 20 percent by 2007 and to 10 percent by 2012.
- Providing gainful employment to the addition to the labour force over the Tenth Plan period.
- Universal access to primary education by 2007.
- Reduction of infant mortality rate (IMR) to 45 per 1000 live births by 2007 and to 28 by 2012.
- Reduction of maternal mortality ratio (MMR) to 20 per 1000 live births by 2007 and to 10 by 2012.
- Increase in forest and tree cover to 25 percent by 2007 and 33 percent by 2012.
- All villages to have access to potable drinking water by 2012.
- Cleaning of all major polluted rivers by 2007 and other notified stretches by 2012.

National Health Committees

Various committees of experts have been appointed by the government from time to time to render advice about different health problems. The reports of these committees have formed an important basis of health planning in India. Major recommendations of some important committees are given below:

BHORE COMMITTEE, 1946⁴

This Committee, known as the Health Survey and Development Committee, was appointed in 1943 with Sir Joseph Bhore as its Chairman. It made comprehensive recommendations for remodelling of health services in India. It laid emphasis on integration of curative and preventive medicine at all levels and recommended a network of primary health centers.

One Primary Health Center was suggested for a population of 40,000. Each PHC was to be manned by two doctors, one nurse, four public health nurses, four midwives, four trained dais, two sanitary inspectors, two health assistants, one pharmacist and fifteen other class IV employees. Secondary Health centers were also envisaged to provide support to PHCs and to coordinate and supervise their functioning.

CHOPRA COMMITTEE

To the uninitiated it must come as a surprise that the government is only now, after half a century of independence, working on a plan to involve the vast numbers of traditional medicine practitioners and their

well-entrenched infrastructure in the public health system. Often there has been a deliberate attempt to relegate such efforts to the sidelines; more frequently, the attempts have failed because they have not been based on realities, nor had proper ground been prepared for such change.

One of the earliest such 'models' is to be found in a document forgotten by everyone except health researchers, known as the Chopra Committee report, published around the same time as the Bhore Committee report which drew the grid-lines for the current health infrastructure. The Chopra Report had drawn an elaborate plan for integrating the several systems of medicine with the allopathic system, even going to the extent of suggesting the manner in which an integrated system of medical education could be evolved. Had the system been put in place the traditional systems today may not have remained in isolation, and the integrated system may well have been in the forefront of medical developments. A little later, perhaps in the early 1960s, yet another initiative began, under the auspices of the Banaras Hindu University where several systems shared diagnostic facilities and offered patients a choice of treatment. Although the experiment was quite successful to begin with, the early enthusiasm petered out in the face of heavy criticism from purists on both sides of the fence. There have been similar local level initiatives, many very successful, though the government's mindless incorporation of traditional medical systems in the form of a nonallopathic doctor at the PHC level has failed miserably, remaining a cosmetic feature.

The current plan of the government to include traditional systems and to systematically workout a list of 10 to 15 diseases for which there could be a choice of therapies, while commendable, requires a lot more groundwork than there seems to be comprehension about. For one, a critically important factor is the system of registration of practitioners. If these systems are to become effectively accessible to people there is a need to revamp some of these institutions and revitalise them. The search for 'old', 'native', 'traditional' remedies, on for some time, is gathering rapid momentum in the increasingly competitive world of pharmaceuticals. This means that these systems need to be studied, adequately documented and protected both through wide usage and necessary patenting.

MUDALIAR COMMITTEE, 1962⁹

This committee, known as the "Health Survey and Planning Committee", headed by Dr AL Mudaliar, was appointed by the Government in 1962 to assess the performance in health sector since the submission of the Bhore Committee report. This committee found the conditions in the PHCs to be unsatisfactory and sugges-

ted that the PHCs already established should be strengthened before new ones are opened.

Strengthening of subdivisional and district hospitals was also advised. It was emphasised that a PHC should not be made to cater to more than 40,000 population and that the curative, preventive and promotive services should be all provided at the PHC. The Mudaliar Committee also recommended that an All India Health Service should be created to replace the erstwhile Indian Medical Service.

CHADHA COMMITTEE, 1963¹⁰

This committee was appointed under the Chairmanship of Dr MS Chadha, the then Director General of Health Services, to advise about the necessary arrangements for the maintenance phase of National Malaria Eradication Program. The committee suggested that the vigilance activity in the NMEP should be carried out by basic health workers (one per 10,000 population), who would function as multipurpose workers and would perform, in addition to malaria work, the duties of family planning and vital statistics data collection under supervision of family planning health assistants.

MUKHERJEE COMMITTEE, 1965

The recommendations of the Chadha Committee, when implemented, were found to be impracticable because the basic health workers, with their multiple functions could do justice neither to malaria work nor to family planning work. The Mukherjee Committee headed by the Secretary of Health, was appointed to review the performance in the area of family planning. The committee suggested that basic health workers should not be given family planning work and that the family planning health assistant should devote their time entirely to family planning.

MUKHERJEE COMMITTEE 1966¹¹

Mutiple activities of the mass programs like family planning, smallpox, leprosy, trachoma, NMEP (maintenance phase), etc. were making it difficult for the states to undertake these effectively because of shortage of funds. A committee of state health secretaries, headed by the Union Health Secretary, Shri Mukherjee, was set up to look into this problem. The committee recommended and worked out the details of a basic health service to be provided at the block level.

JUNGALWALLA COMMITTEE, 1967¹²

This committee, known as the “Committee on Integration of Health Services” was set-up in 1964 under the Chairmanship of Dr N Jungalwalla, the then Director of National Institute of Health Administration and Education (currently, NIHFV). It was asked to look

into various problems related to integration of health services, abolition of private practice by doctors in government service, and the service conditions of doctors. The committee stated that an integrated health service should have two characteristics:

- Different problems should be approached in a unified manner rather than different approaches for different problems.
- Public health programs and medical care should be put under charge of a single administrator at all levels of hierarchy.

The committee recommended integration at all levels of health organization in the country. The following steps were recommended for such integration:

- Unified cadre
- Common seniority
- Recognition of extra qualifications
- Equal pay for equal work
- Special pay for special work
- Abolition of private practice by government doctors
- Improvement in their service conditions.

KARTAR SINGH COMMITTEE, 1973¹³

This committee, headed by the Additional Secretary of Health and titled the “Committee on Multipurpose Workers under Health and Family Planning” was constituted to form a framework for integration of health and medical services at peripheral and supervisory levels. Its, main recommendations were as follows:

1. Various categories of peripheral workers should be amalgamated into a single cadre of multipurpose workers (male and female). The erstwhile auxiliary nurse midwives were to be converted into MPW (F) and the basic health workers, malaria surveillance workers, etc. were to be converted to MPW (M). The work of 3 to 4 male and female MPWs was to be supervised by one health supervisor (male or female, respectively). The existing lady health visitors were to be converted into female health supervisors.
2. One Primary Health Center should cover a population of 50,000. It should be divided into 16 sub-centers (one for 3000-3500 population) each to be staffed by a male and a female health worker.

SHRIVASTAV COMMITTEE, 1975^{14,15}

This committee was set up in 1974 as “Group on Medical Education and Support Manpower” to determine the steps needed to: (i) reorient medical education in accordance with national needs and priorities, and (ii) develop a curriculum for health assistants who were to function as a link between medical officers and multipurpose health workers and who were supposed to provide health care, family welfare and nutritional services.

The four main recommendations of the committee were as follows:

1. A cadre of semiprofessional village level health workers should be developed within the community. These workers should be recruited from amongst the community itself (e.g. school teachers, postmasters, gram sewaks, social workers, etc.) and should look after the primary health needs of the community. They would serve as a link between the community and the primary health center.
2. Within the PHC system, the multipurpose health workers should be the link persons between the village level health worker and the PHC. The work of 2 male and 2 female health workers should be supervised by one male and one female health assistants respectively. These health assistants should be located at the sub-center and not at the PHC.
3. Steps should be taken to develop a referral system from PHC to hospitals at tehsil, district and regional levels and the medical colleges.
4. A medical and health education commission on the lines of the University Grants Commission should be established.

Acceptance of the recommendations of the Shrivastava Committee in 1977 led to the launching of the Rural Health Scheme. The details of this scheme are given in the next chapter.

BAJAJ COMMITTEE, 1986

An "Expert Committee for Health Manpower Planning, Production and Management."^{16,16a} was constituted by the Ministry of Health and Family Welfare, Government of India, in 1985 under the Chairmanship of Dr JS Bajaj member (Health), Planning Commission. The seven major recommendations of the committee are listed below:

1. Formulation of national medical and health education policy.
2. Formulation of national health manpower policy.
3. Establishment of an educational commission for health sciences (ECHS) on the lines of UGC.
4. Establishment of health science universities in various states and union territories.
5. Establishment of health manpower cells at centre and in the states.
6. Vocationalization of education at 10 + 2 levels as regards health related fields with appropriate incentives, so that good quality paramedical personnel may be available in adequate numbers-0
7. Carrying out a realistic health manpower survey.

Health Manpower Planning

The term health manpower development includes three aspects, viz. planning, production and management of health manpower, which includes medical as well as paramedical personnel. These three aspects were

covered by the Bajaj Committee on "Health Manpower Planning, Production and Management".¹⁶ Its major recommendations have been briefly outlined above. The detailed recommendations in the context of health manpower planning are given below:

- A separate national medical and health education policy should be formulated. Such a policy should be focussed at the following issues:
 - Changes required in curricula and training programs for medical and health personnel.
 - Interrelations between functionaries of various grades.
 - Guidelines for manpower production based as per realistic assessment of manpower requirements.
 - Resolving the sharp regional imbalances in manpower availability.
 - Attempts to ensure that personnel at all levels are socially motivated towards rendering community health services.
- Social, moral health and physical education should constitute a holistic approach. These components should be included in the curricula of instructional courses for teachers, particularly physical education instructors.
- Organizational structures should be created for health manpower development. This will necessitate:
 - Improvement in quality of health service statistics.
 - Improvement in functioning of registering bodies for health professionals.
 - Initiation of health manpower studies.
- Basic training of ISM practitioners needs to be strengthened, so that they may gainfully contribute to appropriate national health programs such as those for malaria, leprosy, blindness, family welfare (family planning and MCH), nutrition and immunisation.
- Intensive efforts are needed for health education aimed at producing health related behavioral changes. Examples of such efforts are:
 - Reviewing and restructuring curricula, including redesigning of socially useful productive work (SUPW), so that the latter demonstrates the interdependence of literacy, social and family welfare and health.
 - Incorporation of health component, with well structured pedagogic inputs, in the curriculum for teacher training and education.
 - Development of educational software in health for mass media.
- Health related educational component in school education should be strengthened, especially in grades IX and X. This should be done not merely by adding more topics for didactic teaching but, rather, by more demonstrable learning experiences. This would call for appropriate changes in

instructional methodology. Proper emphasis at grades IX and X stage would lay strong foundations for vocational courses in health at 10 + 2 stage.

- Vocational course at 10 + 2 level should be started in relation to the various categories of health manpower such as Health Workers (male and female), X-ray technicians, Laboratory technicians, Ophthalmic assistants, Dental hygienists, Pharmacists, Occupational therapists, Physiotherapists, Sanitary/health inspectors, etc.
- Proper linkages should be established at district level between schools offering 10 + 2 vocational health courses and the existing health institutions for such paramedical courses.
- Courses currently being offered by health institutions should be reorganized so as to be equated with the 10 + 2 system. The suggested curricular mix should consist of (a) 25 to 30 percent of total instructional time devoted to teaching of languages, humanities, science and mathematics through the school educational infrastructure; (b) 70 to 75 percent time devoted to vocational theory and practice, including on the job training, utilizing the existing training infrastructure for health personnel. The committee suggested that the two years of 10 + 2 course should be phased into four semesters of which the first two should be devoted to a core curriculum common to all courses, and the last two to the chosen area of specialization. The fourth semester should concentrate on practical training. Students passing vocational courses should be able to pursue higher courses in medical or other professional colleges either at the end of 10 + 2 phase or after 3 to 5 years of work experience.
- Incentives need to be given to encourage students to pursue 10 + 2 level vocational courses. For example, (i) Students taking vocational courses at 10 + 2 level should be eligible to join medical or their professional course after passing 10 + 2 course as also after 3 to 5 years of work in their chosen vocation; (ii) Awards and stipends should be given; (iii) Employment should be facilitated for those qualifying the 10 + 2 courses. This can be done by securing recognition from the employment sector for these courses.
- A national health manpower policy should be drawn up in relation to the stated objectives of the national health policy 1983 and national education policy 1986.
- A realistic health manpower survey should be carried out.
- An education commission for health science should be established as a central organisation on the lines of University Grants Commission. The ECHS should prescribe standards of education for all branches of health sciences. It should coordinate with the pro-

fessional councils. The latter should concentrate on matters such as registration of health professionals, maintaining all India register, recognition of degrees or diplomas, inspection of teaching and examination facilities and professional ethics.

- Health science universities should be established in different states as the implementing arm of ECHS for production of health manpower.
- Health manpower cells should be established at center and in the states to coordinate the implementation of health manpower policy.

Over the four decades of planned development, large investments have been made for the development and training of medical manpower in India. There has been a phenomenal growth of medical colleges in the country as reflected in **Table 26.4**.

The training of nurses and other categories of health personnel was also augmented along with the training of medical men.

The government spends nearly Rs. 1,00,000 on the training of a doctor. This expenditure may be considered wasteful if doctors do not serve the country's population. By this yardstick, 25 percent of the training of doctors may be a waste. India has already achieved the norm of 1:3500 for doctor: population, ratio suggested by the Mudaliar Committee. The doctor population ratio in India is 1:2222 (45 doctors per lakh population).⁶ The comparative values for different countries are given in **Table 26.5**.

Imbalance exists regards distribution of doctors. About 68 percent are working in the urban areas and only 32 percent in the rural areas. This is so in spite of the fact that 73.9 percent of our population lives in the rural areas (tribal and hilly areas included) and only 26.1 percent in the urban areas.⁶ However, besides the concentration of doctors in the urban areas, there is imbalance in the distribution of doctors in different states, as seen in **Table 26.6**. This imbalance, too, needs corrective measures and these must form part of our future manpower planning.

Various policy pronouncements of the Government as well as the plan documents have constantly stressed that health and medical services will be provided on priority basis to rural and underprivileged sections of the society. However, the actual pattern of availability of medical and health services is different. Like all other benefits of development, those of health services have also gone in favor of the affluent urban sections of the society.

ANOMALIES IN HEALTH MANPOWER STRUCTURE

There are three main anomalies in the present day health manpower profile in India.

Anomaly Regarding Number

At present, India has sufficient number of doctors in the country, more than that recommended by the Mudaliar

TABLE 26.4: Development of medical education in India^{7,17}

Years	No. of medical colleges*	No. of students admitted	No. of students qualified
1947	25	1983	959
1960-61	60	5874	3387
1965-66	87	10620	5387
1970-71	95	12029	10407
1975-76	106	11213	11982
1980-81	109	11431	12170
1985-86	122	12017	11470
1990-91	128	11389	—
2000-01	175	18000	—

*Till 1980-81, only those recognized by MCI From 1980-81 onward includes unrecognized colleges also.

TABLE 26.5: Physician and beds per 1000 population in selected countries

Countries	No. of physicians/1000 population (1990-1998)	No. of beds/1000 population (1990-1998)
India	0.4	0.8
Australia	2.5	8.5
Bangladesh	0.2	0.3
Myanmar	0.3	0.6
Canada	2.1	4.2
China	2.0	2.9
Japan	1.9	16.5
Mexico	1.6	1.1
Pakistan	0.6	0.7
Singapore	1.4	3.6
Sri Lanka	0.2	2.7
Sweden	3.1	3.8
USA	2.7	3.7

(Source: World Development Indicators; 2001)¹⁸

TABLE 26.6: Population served per doctor engaged under government agencies*

Population per doctor	States /UTs
Below 1000	Chandigarh
1001-3000	Goa, Lakshadweep, Manipur, Pondicherry
3001-5000	Arunchal Pradesh, Sikkim, Tripura, A and N Islands
5001-10,000	Assam, HP, Kerala, Meghalaya, Nagaland, Orissa, Punjab, Daman and Diu, Delhi
10,001-20,000	Gujarat, Haryana, Karnataka, Tamil Nadu, UP, D and N Haveli

*Including hospitals and public sector undertakings. Data not available for all states.

Committee. In fact, the doctor:population ratio in India is higher than Sri Lanka where, incidentally, the infant mortality rate is about one-third of that in India. It must be realized that more doctors do not mean more health. The health of the community, in fact, depends more upon its nursing manpower than upon the number of doctors available. This point is well illustrated in **Table 26.7**. It is seen that Japan and Egypt have a comparable number of doctors per unit population, but Egypt has a high IMR along with a high population:nurse ratio.

ANOMALY REGARDING DISTRIBUTION

This has been already emphasized earlier. What we need today is not to produce more doctors but to deploy them in such a way as to remove the regional and urban rural imbalances.

ANOMALIES REGARDING JOB OPPORTUNITIES

A good manpower policy should ensure that only that much number of professionals are trained as are needed and can be gainfully employed. An idea of the proportion of unemployed doctors can be had from the ratio of those registered with the employment exchanges to those registered with the respective professional council. This ratio is 8.6 percent in case of doctors (33,583 out of 3,91,226) and 3.2 percent in case of nurses.⁶ It is important that job opportunities should be created in rural areas where the population: doctor ratio is very high compared to urban areas.

Health Administration and Management

The field of organization, administration and management has become immensely important not only in public administration and corporate sector but, also, in the field of health. No health administrator or public health specialist can afford to be ignorant in this area. However, this field is a speciality in itself. Only introduction to certain principles can be given here. This section will be dealt within the following subsections:

- Administration
- Management
- Organization
- Principles of organization
- Organizational behavior
- Overview of management, administration and organization
- Management techniques
- Characteristics of good health service
- Challenges in health care administration.

Administration

Administration is closely related to management but has a wider scope. The concept is manifest in the following definitions:

- Administration is the direction, coordination and control of many persons to achieve some purpose or objective (LD White).
- Administration is the organization and direction of human and material resources to achieve desired ends (Pffiffer and Presthus).
- Administration, in its broadest sense, is defined as the activities of groups cooperating to accomplish common goals (Herbert A Simon).

TABLE 26.7: Health personnel per lakh population and IMR in various countries

Country	Doctor /100,000 population*	Nurse /100,000 population*	No. nurses / doctors*	No. midwives/ 100,000 population*	No. dentists/ 100,000 population*	Infant mortality rate**
Nepal (1995)	4	5	1.25	7.4	—	72
Bangladesh (1997)	20	11	0.55	—	—	79
Pakistan (1996-97)	57	34	0.60	—	2.3	95
India (1992)	48	45	0.94	—	—	69
India (1951)	5843 (pop per doctor)	21818 (pop/nurse)***	0.27	—	—	140
Egypt (1996)	202	233	1.15	—	25	51
Myanmar (1999)	29.7	26.1	0.88	22.1	2.1	80
Indonesia (1994)	16	50	3.12	26	—	40
Kenya (1995)	13.2	90.1	6.82	—	2.2	75
Afganistan (1997)	11	18	1.64	—	1	165
Brazil (1996)	127.2	41.3	0.32	—	85.1	36
Mexico (1990-95)	186.4	86.5	0.46	—	65.9	28
Sri Lanka (1999)	36.5	102.7	2.81	41.9	2.5	17
USA (1995-96)	279	972	3.48	—	59.8	7
UK (1989-93)	164	497	3.03	43.3	39.8	6
Japan (1996)	193.2	744.9	3.86	18.9	68.6	4

(Source: * WHO Estimates of Health Personnel (1998)¹⁹

** UNICEF: State of the World's Children 2000)²⁰

*** Includes Nurse Midwives.

- Administration is determined action taken in pursuit of conscious purpose. It is the systematic ordering of affairs and calculated use of resources, aimed at making those things happen which we want to happen and simultaneously preventing developments that fail to square with our intentions. It is the marshalling of available labor and materials in order to gain that which is desired at the lowest cost of energy, time and money (John A Vieg).
- Administration is a variety of component elements which together in action produce the result of getting done a defined task with which a group of people is charged. Administration, primarily, is the direction of people in association to achieve some goal temporarily shared. It is the inclusive process of integrating human efforts so that a desired result is obtained (Ordiway Tead).

According to Henri Fayol, the enunciator of the formal organization theory, administration comprises the following five elements: forecasting and planning, organizing, commanding, coordinating, and controlling. *To administer* is to forecast and plan, to organize, to command, to coordinate and to control. *To forecast and plan* means examining the future and drawing up the plan of action. *To organize* means building up the dual structure, material and human, of the undertaking. *To command* means maintaining activity among the personnel. *To coordinate* means binding together, unifying and harmonising all activity and effort. *To control* means seeing that everything occurs in conformity with established rules and expressed command. In simple words, *administration* may be defined as the management of affairs with the use of well thought out principles and practices and rationalized techniques to

achieve certain objectives.² *Health administration* is a branch of public administration which deals with matters relating to promotion of health, preventive services, medical care, rehabilitation, development of health manpower and medical education and training. The purpose of public health administration is to provide total health services to the people with economy and efficiency.² Health administration must use the knowledge of health economics to achieve proper economy.

The efforts of *public health administration* are directed towards raising the level of health of the community. A good public health administrator is one who carries out this task with maximum efficiency and minimum delay.

Management²¹

The term management is generally understood as a process of getting things done through others. A manager in an organization manages to realize the established aims of the organization by directing its operations and coordinating the efforts of people working in it. So, management is the effective use and coordination of resources such as money, materials and manpower, to achieve defined objectives with maximum efficiency. The success of an organization depends on its management. The productiveness of the resources, i.e. men, money and materials, depends to a large extent upon the quality and performance of the manager and the effectiveness of his direction.

There are a variety of views about management. In its traditional interpretation, the term 'management' refers to the activities (and often the group of people),

involved in four general functions—planning, organizing resources, leading and controlling or coordinating.

Planning includes identifying goals, objectives, methods and resources needed to carry out methods, responsibilities, and dates for completion of tasks. Organizing resources are needed to achieve the goals in an optimum fashion. Leading includes setting directions for the organization, groups and individuals and also influences people to follow that direction. Controlling or coordinating refers to the organization's systems, processes and structures to reach effectively and efficiently reach goals and objectives. This includes ongoing collection of feedback and monitoring and adjustment of systems, processes and structures accordingly.

To most people the term “management” probably means the group of people (executives and other managers) who are primarily responsible for making decisions in the organization. In a nonprofit organization, the term “management” might refer to all or any of the activities of the board, executive director and/or program directors.

More recent interpretations of management assert that management needs to focus more on leadership skills, e.g. establishing vision and goals, communicating the vision and goals and guiding others to accomplish them. This new view also argues that leadership must be more facilitative, participative and empowering in how visions and goals are established and carried out.

DEFINITIONS

Management has been variously defined by different experts. Some definitions are as follows:

- Management is the creation and control of technological and human environment of an organization in which human skills and capacities of individuals and groups find full scope for their effective use in order to accomplish the objectives for which an enterprise has been set up. It is involved in the relationships of the individual, the group, the organization and the environment (A Dassgupta).
- Management is the act of securing maximum results with a minimum of effort so as to secure maximum prosperity and happiness for both the employer and the employees, and give the public the best possible services (John F Mee).
- Management embraces all duties and functions that pertain to the initiation of an enterprise, its financing, the establishment of all major policies, the provision of all necessary equipments, the outlining of the general form of organization under which the enterprise is to operate and the selection of the principal offices (DS Kimbell).
- Management is the accomplishing of a predetermined objective through the efforts of other people (George R Terry).

- Management is a distinct process consisting of planning, organizing, actuating and controlling, performed to determine and accomplish the objectives by the use of people and resources (George R Terry).
- Management is the process of making decisions and issuing commands on behalf of an organization's membership groups, taking into consideration the complex of objectives, limitations and standards underlying the production and distribution of value, required to satisfy membership's needs (BJ Hodge and HJ Johnson).

FUNCTIONS

The main management functions required to be performed for management are planning, implementation and evaluation. Management is nothing but a process of making decisions. “**Decisions related to planning**” include setting objectives, outlining activities towards achieving these objectives and procuring resources required for performing these activities. “**Decisions related to implementation**” are concerned with execution of all activities as planned, deployment of manpower, allocation and mobilization of financial and physical resources and processing of information needed. “**Decisions related to evaluating**” deal with effectiveness or achievement of results, efficiency in the performance of the activities and economic use of all types of resources.

Management principles can be applied at all levels of an organization or system, starting from the highest central level down to the hospitals and the PHCs and subcentres. Management is a function not only of those at the top of the hierarchy. Good health management means adaptation to the needs of changing situation, optimum utilization of limited resources, improvement in the standard and quality of services provided and maintenance of high staff morale aimed at providing good health care to the population.

One of the important functions of a manager is coordination. **Coordination** is defined as the process by which managers achieve integrated patterns of group and individual effort. To coordinate is to develop unity of action in common purposes. Coordination is often wrongly confused with cooperation. Cooperation is certainly desirable between two individuals or organizations and helps in coordination. It is important to remember that individuals or organizations may cooperate, but do not coordinate, on their own. Any degree of coordination between the cooperating individuals is coincidental.²¹ It is the task of a manager to manage the activities of two entities so as to ensure that the coordination achieved is planned and maximal, rather than incidental and marginal.

Organization

An organization is a group of people whose activities are consciously coordinated towards a common objective or objectives. An organization comes into being when there are persons able to communicate with each other, who are willing to contribute action, to accomplish a common objective. There are four elements of an organization: **Purpose, process, persons and place (four Ps)**.

Efforts have been made during last 100 years to improve administrative performance or productivity and to learn more about human behavior in organizations. These efforts have led to development of organizational theories, which are principally the following:

- The classical theory of organization
- The human relations theory of organization
- The neohuman relations theory of organization
- The system theory of organization.

The first of these, the classical theory, has the following three strands:

- Scientific management
- Formal organization theory
- Bureaucracy.

Principles of Organization

Fayol propounded 14 principles of organization as listed below:

1. Division of work
2. Authority
3. Discipline
4. Unity of command
5. Unity of direction
6. Subordination of individual interest to general interest
7. Remuneration
8. Centralization or decentralization
9. Scalar chain (Hierarchy)
10. Order
11. Equity
12. Stability of tenure
13. Initiative
14. Esprit de corps.

Luther Gullick has more concisely grouped the principles of organization into a group of 7 principles contained in the acronym POSDCORB. These are briefly described below:

1. *Planning*, that is, working out in broad outline the things that need to be done and the methods for doing them to accomplish the purpose set for the enterprise.
2. *Organizing*, that is, the establishment of the formal structure of authority through which work subdivisions are arranged, defined and coordinated for the defined objectives.

3. *Staffing*, that is, the whole personnel function of bringing in and training the staff and maintaining favorable conditions of work.
4. *Directing*, that is, the continuous task of making decisions and embodying them in specific and general orders and instructions as also serving as the leader of the enterprise.
5. *Coordinating*, that is, the all important duty of interrelating the various parts of the work.
6. *Reporting*, that is, keeping those, to whom the executive is responsible, informed as to what is going on, which, thus, includes keeping himself and his subordinates informed through records, research and inspection.
7. *Budgeting*, which includes all that goes with budgeting in the form of fiscal planning, accounting and control.²

Organizational Behavior

“Organizational behavior is the field that seeks to comprehend and predict human behavior in organizational settings through the scientific study of individual processes, group processes, and organizational structure and function.²² If a manager has to achieve maximum efficiency in his organization, he must understand why individuals work, what motivates them for better performance and how to ensure their maximum contribution as a group towards maximal output of the organization. As such, a manager must be able to understand and analyze organizational behavior. There are several dimensions of organizational behavior. These include (i) Motivation, (ii) Group dynamics, (iii) Social roles, (iv) Health team approach, (v) Communication, (vi) Leadership, (vii) Supervision, (viii) Morale, (ix) Grievance redress, (x) Discipline, (xi) Conflict, (xii) Innovation, (xiii) Public relations.

Overview of Management, Administration and Organization

The above three terms are obviously interrelated, yet have different conceptual meaning. *Administration* has a wide function involving more of thinking, planning, policy making, decision making and coordinating. *Management* is a more concrete function of getting things done and implementing the laid down policies. *Organization* involves ensuring that different components of the enterprise, especially the personnel, work together harmoniously towards an optimum outcome. These three concepts are tabulated below in a comparative manner for sake of clarification.

Management Techniques

Mere formulation of a plan does not achieve much. The plan has to be implemented. If it is implemented successfully, the desired objectives will be achieved.

In view of the importance of management techniques, the WHO has reviewed these in the context of health.^{1,23} Successful implementation requires considerable skills in management so as to lead a health team and to support, supervise and evaluate health activities in an area. The use of scientific management techniques has paid rich dividends not only in the industrial sector but also in education and health sectors. These are briefly described below:

ORGANIZATIONAL DESIGN

Health services have to be so organized that they meet the health needs as well as the people’s demands. Proper organization aims at achieving efficient delivery of services. Poor organization, on the other hand, results in wastage of precious resources. It is necessary to review the organizational structure of health service every few years since it may need to be altered because of changing concepts, problems and techniques.

PERSONNEL MANAGEMENT (HUMAN RESOURCE DEVELOPMENT)

Its aim is to use the human resources skilfully and efficiently. It implies proper selection, training, motivation, job allocation and providing incentives, promotions and opportunities for professional advancement.

MANAGEMENT INFORMATION SYSTEM (MIS)

It is an analytical tool that helps in identifying problem areas and taking better and more informed decisions and timely remedial measures. It is not a substitute for management decisions but is the most powerful tool for decision making. It should be remembered that *bad information always leads to bad management*.

Collection, compilation and analysis of programme information is an integral component of the implementation of a program. It is a strong management tool that guides the implementators about setting priorities, adjustment of strategies, and assist in self appraisal. A strong and uniform MIS helps the planning process at all levels.

An efficient MIS would include easy collection, timely and regular flow and prompt utilization of data.

There are three components of an MIS:

1. Data Collection
2. Data Flow
3. Data Analysis and Evaluation

The following should be decided in advance before putting an MIS in place:

1. What information is to be collected?
2. Why is the specific information needed?
3. Where will the information be collected from?
4. When will the information be collected?
5. How will the information be recorded and transmitted?

The temptation to collect all data under the sun should be resisted and only relevant information, which will be used effectively should be collected. MIS should not be reduced merely to Information Collection System.

MANAGEMENT BY OBJECTIVES (MBO)

The essence of this system is to set forth objectives for different units and subunits of the organization, asking them to prepare their own short-term plans of action.

MBO—An effective planning tool: MBO is an collaborative process whereby the Leader and team members can jointly determine objectives for each team members. MBO begins when the Team Leader explains the goals for his group. The team members take the goals and propose objective for his/her particular job. In case of any modification of individual’s objectives, it is accomplished through negotiation since the Team Leader has resources to help the team member commit to the achievement of the objective. Thus, a set of verifiable objectives for each team member are jointly determined, prioritized and formalised. Transperancy in Communication is the key factor in determining MBO’s success or failure.

MBO process: Objectives are the drivers of planning processes. The organization’s success ultimately depends on the combined outcomes of its objectives.

Defining a objective: An Objective is simply a statement of what is to be done and should be stated in terms of results. A mnemonic and to-write objectives is SMART (Specific, Measurable, Attainable, Result-oriented, Time-Limited).

ADMINISTRATION, MANAGEMENT AND ORGANIZATION

Administration	Management	Organization
<ul style="list-style-type: none"> • Concerned more with determination of objectives and policies • Provides a sketch of the enterprise • Has legislative and determinative function • Influenced mainly by public opinion and other outside forces • Mainly a top level function • Involves thinking and planning 	<ul style="list-style-type: none"> • Concerned more with implementation of policies • Provides the entire body • Has executive function • Influenced mainly by administrative decisions • Lower level function • Involves doing and acting 	<ul style="list-style-type: none"> • Concerned more with putting together different parts of an enterprise into working order • Provides the nervous system of the enterprise • Has organic function • Influenced by basic objectives and policies of the enterprise • Lower level function • Involves doing and acting

- **Specific:** An objective must be specific with a single key result. If more than one result is to be accomplished, more than one objective should be written. Just knowing what is to be accomplished is a big step toward achieving it.

Once you have clarified what you want to achieve, your attention will be focussed on the objective that you deliberately set. You will be doing something important to you.

- **Measurable:** An objective must be measurable. If possible, state the objective as a quantity. Some objectives are more difficult to measure than others. However, difficulty does not mean that they cannot be measured.
- **Attainable:** An objective must be attainable with the resources that are available. It must be realistic. Many objectives are realistic. Yet, the time it takes to achieve them may be unrealistic. For example, it is realistic to want to lose ten pounds of weight. However, it is unrealistic to want to lose ten pounds in one week.

What barriers stand between you and your objective? How will each barrier be overcome and within that time frame?

- **Result-oriented:** The objective should be in line with the goals of the organization. The successful completion of the objective should make a difference.

How will this objective help the organization move ahead? Is the objective aligned with

- **Time limited:** The objective should be traceable. Specific objectives enable time priorities to be set and time to be used on objectives that really matter.

Do you realistically establish the time frame? Will other competing demands cause delay? Will you be able to overcome those demands to accomplish the objective you have set in the time frame you have established?

Tips: Although the rules are difficult to establish, the following may be useful when writing an objective.

- Identify a single key result for each objective.
- Give the date of the estimated completion.
- Be sure the objective is one you can control.

To test for validity of **SMART** objectives, ask yourself the following questions.

S (Specific) = Exactly, what is my objective?

M (Measurable) = What would a good job look like?

A (Attainable) = Is my objective feasible?

R (Result Oriented) = Is my objective meaningful?

T (Time Limited) = Is my objective traceable?

MANAGEMENT BY EXCEPTION

This is defined as follows:²⁴

- A principle of management in which a management decision that cannot be made at one level is passed up to the next level for a decision, i.e.

exceptional decisions are passed up the management tree.

- The principle used in budgetary control in which items of income or expenditure that show no variances or small variances require no action, whereas exceptional items showing adverse variances to an unacceptable degree require action to be taken.

Some workers want to know what they have to do to just get by, they do not have any other interest. Management by exception is an effective approach for this kind of worker. Anyone can see whether they are about to run out of gas when they drive. It is important for workers to know that they can control their own future by performing above the minimum expectations. In summary, the basic values of MBE are defensive: conservatism and containment.

The basic approach to MBE consists of definition of exceptions, identification of exceptions, and follow through.

COST METHODS

The basic feature is that an attempt is made to weigh the input or costs against the output or results. In the *cost-benefit analysis*, the cost of resources and results is computed in monetary terms and the utility of the project is expressed in terms of the ratio between the two. This approach is not practical in most health related projects because, for example, the monetary value of an infant death averted or a leprosy case cured cannot be calculated. For this reason, it is better to use *cost effectiveness analysis* which is similar to the former, except that the output is expressed as the results achieved (e.g. the number of lives saved), without attempting to quantify them in monetary terms. This is described in detail in the next chapter.

SYSTEMS ANALYSIS

The basic approach in systems analysis is to find the cost effectiveness of the available alternatives. It involves investigating the problem, setting objectives, listing various possible solutions, evaluating the alternatives from the point of view of cost effectiveness, redefining the objectives if necessary and deciding upon the most cost effective alternative. It may be mentioned that a Health Service System may be made of many independent subsystems.

NETWORK ANALYSIS

A network is a graphic plan of various events and activities that must be completed before the desired objective is achieved. A well-known type of network

technique is PERT (*Program Evaluation and Review Technique*). Another related network technique is the *Critical Path Method (CPM)*. Both these techniques use an arrow diagram to illustrate the logical sequence in which events and activities must take place. This makes it possible to calculate the time by which each activity must be completed, as also to identify critical points in the chain of activities and events.

CRITICAL PATH ANALYSIS

Critical path analysis is an extremely effective method of analyzing a complex project where a job has to be completed on time, critical path analysis helps you to focus on the essential activities to which attention and resources should be devoted. It gives an effective basis for the scheduling and monitoring of progress.

Sequential and parallel activities: The essential concept behind Critical Path Analysis is that some plan activities are dependent on other activities being completed first. For example, you should not start building a bridge unless you have designed it first?

These dependent activities need to be completed in a sequence, with each activity being more or less completed before the next activity can begin. Dependent activities are also called 'sequential activities.' Other activities are not dependent on completion of any other tasks, or may be done at any time before or after a particular stage is reached. These are nondependent or 'parallel' tasks.

Critical Path Analysis is an effective and powerful method of assessing.

- Tasks which must be carried out
- Where parallel activity can be carried out
- The shortest time in which a project can be completed
- Resources needed to achieve a project
- The sequence of activities, scheduling, and timings involved
- Task priorities

The difference between PERT (Program Evaluation and Review Technique) and CPM is in the times for each activity or outcome. CPM simply takes the expected (usually average) time, PERT uses the best case, expected case, and worst case estimates to calculate the duration.

WORK SAMPLING

Sampling techniques provide quantitative measurement of various activities performed by one or more individuals. These are used to make quick assessment of attributes in activities by systematic observations and recording of activities at random intervals. It is possible to get a quick estimate of time needed to do specified jobs, which helps in development of appropriate job description, training of different categories of personnel

and determining the manpower requirement in an organization.

LINEAR PROGRAMMING

Linear programming is a mathematical technique which helps to get optimal output at minimum cost by optimum allocation of resources between two or more alternatives in the light of certain goals and existing conditions.

Characteristics of a Good Health Service

The ultimate aim of public health administration is to provide a good health service to the community. Such a service should have the following characteristics:

- **Comprehensive:** It should deal with all the five levels of prevention, i.e. promotion of health, specific protection, early diagnosis and treatment, limitation of disability and rehabilitation.
- **Integrated:** All the above aspects should be combined and should be preferably available from a single source, either at the same place or through a system of simple and easy referral.
- **Universal:** It should cater to the needs of all members of the community, young and old, rich and poor, well and sick, employed and retired, etc.
- **Continuous:** All services, once started, should continue to be rendered and no withdrawal should take place due to shortage of men, money and materials.
- **Up-to-date:** All facilities, services and latest technology should be available in the fields of prevention, diagnosis, cure and rehabilitation, etc.
- **Free:** The services should preferably be free at all times, especially in case of emergency.
- **Accessible:** The services should be located as near the people as possible for their effective use.
- **Acceptable:** The services designed must be acceptable to the recipients, so that public cooperation at all levels is ensured and the service are fully utilized.
- **Holistic:** The services must cover the total environment at home, school, work, and the place of recreation.

Challenges in Health Care Administration

The present health situation in developing countries, including India, is far from satisfactory. It is necessary to be aware of the major challenges in the area of health care administration, as listed below.²

- **Lack of coordination and linkages:** This calls for action at three levels:
 - Coordination of health with sectors like agriculture, education, social welfare, public works, housing, environment, etc.
 - Pooling the efforts of all health agencies to achieve maximum output. This would include

joint action among government, international, voluntary, and private agencies in all systems of medicine, western as well as indigenous.

- Integrating into a single package the various health services like maternal and child health, family planning, prevention of communicable diseases, environmental sanitation, health education, etc.
- *Lack of equity of distribution and adequacy of coverage in relation to need:* The problem has been beautifully described by David Morley in the following words: “Three quarters of our population are rural, yet three quarters of our medical resources are spent in the towns where three quarter of our doctors live. Three quarters of the people die from diseases which could be prevented at low cost and yet three quarters of medical budgets are spent on curative services.”² The following three actions are needed to tackle this problem:
 1. Health needs of the largest group should be attended first, rather than catering to the demands of a particular section of society.
 2. The health care should be provided through technology that may reach all. Thus investment in highly sophisticated technology to be used only by a few is not desirable.
 3. Health care through the use of auxiliaries should be encouraged.
- *Poor financial allocation to health care delivery:* Developing countries give low priority to health while allocating resources to health care. It is given in **Table 26.8**. It is obvious that there is a need to step up the budgetary health allocation in India.
- *Poor utilization of existing resources:* There is maldistribution of health expenditure out of the existing budgetary allocation. Firstly, there is disproportionate expenditure on health services in urban areas compared to rural areas. Secondly, there is heavy expenditure on secondary and tertiary care services compared to that on primary care services. Another serious problem is wastage of huge resources due to inappropriate technology and inefficient management.¹
- *Lack of adequate information for health planning, implementation and evaluation:* Correct and timely information is vital for proper functioning of any organization. The need for utilizing an appropriate management information system has already been emphasized.
- *Lack of a national health policy:* The absence of a health policy in most countries has resulted in fragmented approach in different areas. India adopted the National Health Policy in 1983.²⁵ It has recently been revised.
- *Lack of a sound manpower policy:* Most developing countries have never formulated or implemented a health manpower policy. Such a policy is the main

TABLE 26.8: Public health expenditure in different countries

Country/Region	Public health expenditure as % GDP (1990-1998)
World	2.6
High Income Countries	6.0
Middle Income Countries	2.5
Low Income Countries	1.2
Sub-Saharan Africa	1.7
Ghana	1.8
Mauritius	1.8
South Asia	0.9
Myanmar	0.2
India	0.8
Indonesia	0.7
Nepal	1.3
Pakistan	0.9
Sri Lanka	1.4
Thailand	1.9
Middle East and North Africa	2.3
USA	5.8
UK	5.6

Source: World Bank: World Development Indicators 2001¹⁸

requirement for the development of a functionally effective health. Care system. According to WHO, “the most crucial requirement for the improvement of the world health situation is undoubtedly the development of health manpower that is properly attuned to the health problems of the people and suitably trained to respond to health program and service needs.”²⁶

- *Lack of community participation and involvement:* Many technically sound and well intentioned health programs have failed because of lack of community acceptance and participation. This happens when the people are not actively associated with them and regard them as government programs imposed upon the people.²⁷

It must be understood that health cannot be imposed; it can only be acquired. Participation of beneficiaries based on their enlightenment is, therefore, necessary.

- *Lack of administrative capability and competence:* This is the most scarce of all resources in the developing world. The general administrator is fit only to maintain law and order and is not suitably equipped to deal with the problems of development and welfare economics. Hence it is necessary to provide training in public health administration to technical experts.²
- *Lack of decentralization:* The national health system in India is too complex to be run on a centralized basis. It is necessary to decentralize the administrative process. The process should include extensive delegation of function to lower levels, so that this may produce effective decentralization in staff management, budgetary control, application of rules and regulations and, if possible, financing as well.²

Government Health Organization in India

Central Level

Health is a State subject under the Constitution of India. The Center deals mainly with international, national and interstate health matters. The Center is also responsible for the execution of health programs in the centrally administered areas. It advises and helps the States on all health matters. Coordination in matters related to health is achieved through a Central Health Council. All State Health Ministers are its members and the Union Minister of Health is the Chairman. It meets once in a year to draft policy matters. The Director General of Health Services acts as the secretary. The State heads of health or medical departments are also present to advise their Ministers in technical matters.

The responsibilities of the Central and State Governments in the area of health are defined under Article 246 of the Constitution as follows:

UNION LIST

- International obligations such as International Sanitary Regulations regarding port quarantine.
- Administration of central institutes such as All India Institute of Hygiene and Public Health, Kolkata, National Institute of Communicable Diseases, Delhi, National Institute of Health and Family Welfare, Delhi, etc.
- Promotion of research through research bodies such as the Indian Council of Medical Research.
- Regulation and development of medical, dental, pharmaceutical and nursing education and professions through their respective councils.
- Regulation of manufacture and sale of biological products and drugs, including drug standards.
- Undertaking census, collecting and publishing health and vital statistics data.
- Coordination with States in their Health Programs, giving them technical and financial assistance and procuring for them facilities from international agencies.
- Coordination with other ministries in matters related to health.
- Health regulations regarding labor in general and mines and oil fields in particular.

CONCURRENT LIST

Both the Center and the States have simultaneous power of legislation in relation to subjects in the concurrent list. The subjects in this list relate to:

- Interstate spread of disease
- Prevention of adulteration of foods
- Control of drugs and poisons

- Vital statistics
- Labour welfare
- Minor ports
- Population control and family planning
- Social and economic planning.

UNION MINISTRY OF HEALTH AND FAMILY WELFARE

The Union Ministry is headed by the Cabinet Minister with a Minister of State and a Deputy Minister under him. The Ministry has two departments—Department of Health and Department of Family Welfare. The Department of Family Welfare is headed by a Secretary, the technical matters being looked after by the Commissioner for Family Welfare. The Department of Health is headed by the Secretary to the Ministry.

The Director General of Health Services holds an office attached to the Ministry. He renders technical advice on all health matters inclusive of drug control and prevention of food adulteration, but exclusive of matters relating to local self government, national water supply and sanitation schemes. The Directorate has three wings—Public Health Wing, Medical Wing and Administrative Wing. The first is headed by an additional Director General and the second by a Deputy Director General. The main functions of the DGHS are as follows:

- Conducting various national health programs.
- Organizing health services in the form of Central Government Health Scheme.
- Providing Medical Education through the colleges and institutions under its control, e.g. Maulana Azad and Lady Hardinge Medical Colleges in Delhi, JIPMER, Pondicherry, Raj Kumari Amrit Kaur College of Nursing, Delhi, All India Institute of Hygiene and Public Health, Kolkata, etc.
- Medical research, through Indian Council of Medical Research and the Institutes under it, as also other institutions, such as the Central Research Institute, Kasauli.
- International health and quarantine at major ports and international airports.
- Drug control.
- Medical stores and supplies.
- Health education through Central Health Education Bureau.
- Health intelligence, through Central Health Intelligence Bureau.

The Department of Family Welfare has responsibility for Family Planning as well as Maternal and Child Health. Six Regional Directors of Health and Family Welfare at Ahmedabad, Bangalore, Bhopal, Kolkata, Lucknow and Chandigarh coordinate with the State Governments and voluntary agencies to ensure proper implementation.

State Level

There are 28 States in the country. Health, as stated earlier, is a State subject. Therefore, the pattern of organization, state of integration, level of health services, public health laws and scales of pay for health personnel differ from state to state. The aim, however, of all States and their Public Health Administration is the same—health, happiness and longevity for all the people.

STATE MINISTRY OF HEALTH

The Ministry has a Minister and Deputy Minister of Health. The Bhole Committee recommended that the post of Secretary to the Health Ministry should be held by the Director of Health Services, but this has not been put into practice, barring exceptions. The Secretary and Joint Secretary, etc. in the Ministry continue to be appointed from the IAS cadre.

STATE HEALTH DIRECTORATE

Till the time of independence, there were separate medical and public health departments in the States. The Bhole Committee⁴ recommended integration of curative and preventive services. The lead was taken by West Bengal which created a post of Director of Health Services in 1947.

The process of integration has now been completed in most States. The usual pattern now is that the State Health Directorate is headed by a Director, usually known as Director of Health Services (in some States, known as the Director of Health and Family Welfare or as Director of Medical and Health Services). He is assisted by a suitable number of deputies (Joint Director, Deputy Director, Assistant Director, etc.) to look after various public health and medical services. Some states also have a separate Director of Medical Education. There is a move that the public health engineering department of the state should also be placed under the State Health Directorate.

District Level

Each state in Indian union is divided into districts. Total population in each district, urban as well as rural, varies from one to three million. Just as in case of states, some autonomy has been given to urban and rural areas in the district as well. The autonomous bodies or local self-government are called Corporations and Municipal Committees in the cities, Zilla Parishads in rural districts and Gram Panchayats and Nagar Panchayats (Town Area Committees) in villages and small towns.

HEALTH ORGANIZATION IN URBAN AREAS

There are three types of local self government in urban areas of a district, depending upon the size of population:

1. Town areas committees (5 to 10,000)
2. Municipal Board or Municipality (10 to 200,000)
3. Corporation (Above 200,000)

All the above three are elected bodies.

The *town area committee* is like a Panchayat in the rural areas. Its functions are primarily limited to provision of sanitary services. The *Municipal Board* or municipality has more diverse functions. These include regulations regarding construction of houses, latrines and urinals, hotels, and markets; provision of water supply, drainage and disposal of refuse and excreta, disposal of the dead, registration of births and deaths, keeping of dogs and control of communicable diseases. The *Municipal Corporation* is also an elected body. The people elect the Councillors, who then elect a Mayor. The executive staff of the corporation includes the Commissioner, the health and engineering wings and the secretariat. The corporation provides essentially the same services as the municipality, but on a larger scale. It also maintains hospitals and dispensaries.

HEALTH ORGANIZATION IN RURAL AREAS

In order to understand the health set up in the villages, it is essential to appreciate the existing system of administration and its historical background. This can be described in four phases.

Up to 1923: District Administration alone: The Collector or Deputy Commissioner acted as the chief administrative head of the district as well as the District Magistrate before independence. He was assisted by 2 to 3 Assistant or Deputy Collectors in charge of Subdivisions and 5 to 10 Mamlatdars or Tehsildars in charge of Talukas or Tehsils into which the district was divided. He coordinated the activities of heads of departments in the district, such as the Civil Surgeon, District Health Officer, Executive Engineer and Agriculture, Education and Veterinary Officers, etc.

1923-1951: District Administration plus Local Boards: There was no local autonomy till District Local Boards came into existence in 1923, after the visit of Simon Commission in 1920. These Boards were given some powers for self-government in rural areas of the district.

1952-1961: Community Development: After independence, the Government adopted the goal of “Welfare State” and launched a scheme called ‘Community Development Program’ on 2nd October,

1952 for comprehensive and intensive development of rural areas. Each district was divided and developed Blockwise, there being a total of 5400 Blocks in the country. An average Block, when established in 1952, covered 66,000 population in about 100 villages, scattered over an area of 256 sq km.

Objectives: The objectives of the CDP were to fight on a common platform the following three enemies of the rural people:

1. Poverty, by improvement of economic conditions through improved methods of agriculture, small scale industries, cooperative movement, etc.
2. Ignorance, by social awakening of people through education, (providing each village with a primary school) and social welfare organization.
3. Ill-health, by establishment of integrated health services on the lines recommended by Bhore Committee and by improvement of water supply and sanitation.

The Community Development Program was launched with the realization that education, health, and economic betterment are interdependent and that one cannot be promoted while neglecting the other two.

The CDP envisaged a 5-year phase of intensive development followed by another 5 years postintensive phase. The budget was placed with the Block Development Officer and amounted to Rs. 12 lakh during the first 5 years and Rs. 5 lakh for next 5 years. This brought about improvement in economic condition, health, literacy and communications, etc. and raised the general standard of living.

At district level, the development of each Block was guided by the District Development Board. The latter had the collector as its Chairman while the district heads of other departments, prominent social workers of the district and local MLAs and members of parliament were its members. The president of the District Local Board was an ordinary member.

After 1961: Panchayati Raj:²⁸ By now, there were three agencies in the district: General Administration, District Local Board and Community Development Department. The Planning Commission and National Development Committee decided in 1956 to combine all the three and handover the same to well organised bodies at different levels, (village, taluka, and district), in the interest of economy and efficiency. Under *Panchayat Act, 1961*, the district administration was reorganized into 3 tier Panchayati Raj. Self governing autonomous bodies were formed at different levels as follows:

- For each villages or group of villages with population from 1000 to 10,000, there is a Gram Panchayat. If the population is over 10,000 up to 30,000, there is a Nagar Panchayat. The Gram Panchayat is constituted by 15 to 30 elected members, who in

turn elect a Sarpanch, Deputy Sarpanch and Panchayat Secretary.

- For each block is a Panchayat Samiti which is constituted by village Sarpanchs, representatives of women, scheduled castes and tribes and cooperative societies as well as the MLAs and MPs resident in the area. The Block Development Officer acts as the Secretary while the Chairman and Vice-chairman have to be elected by the samiti.
- For each district there is a District or Zila Parishad which is an autonomous body for the district as a whole, responsible to the State Assembly. It is constituted by heads of Panchayat Samitis, local MLAs and MPs and representatives of women, scheduled castes, etc. The District Development or Planning Officer acts as its Secretary. The President and Vice-president are elected by the Zila Parishad.

At all levels of Panchayati Raj, special committees are appointed to render advice to the executives on different aspects. One of these is the health committee. At district level, it advises the District Health Officer incharge of the primary health center. The health duties of the Panchayats are defined in schedules I and II of the Act.

Contrary to general belief, health care is best provided through small scale decentralized activity and is, hence, most suitable for Panchayati Raj. The present top-down system of health care needs to be changed.

All routine administration and development work is handed over to the Panchayat while law and order and some special matters, such as civil supplies, remain with the Collector. The Panchayat system also has a judicial wing in the nature of Nyaya Panchayat. One Nyaya Panchayat is responsible for five Gram Panchayats. It has power to try civil and minor criminal offences and also to impose fine up to Rs. 100.

73rd Constitutional Amendment 1992: The year 1992 was a watershed year in the history of rural development. Four decades after the Indian Constitution became operative, the Panchayati Raj Institutions (PRIs), hitherto enshrined in the Directive Principles of State Policy and, therefore, nonjusticiable, have ultimately been given legal sanction. Three main features of this Amendment are as follows:

1. Provisions have been made for the devolution of adequate administrative and financial powers to the Panchayati Raj and Nagarpalika Institutions.
2. It has been made mandatory for the state governments to hold elections within six months in the event of the dissolution of these institutions.
3. Provision has been made for reservation for scheduled castes, scheduled tribes and women to ensure their active participation in the allround development of the villages.

The Amendment confers constitutional status to panchayats and nagarpalikas. The PRIs have, for long,

been unviable due to lack of powers and financial resources, as also prolonged supersession. The state governments are now required to establish, a uniform Panchayati Raj and Nagarpalika system. Like the central and state governments, this third tier will have its own financial resources and a list of subjects under its independent jurisdiction. It is hoped that this will help in increasing people's participation in health, which is an important component of the Primary Health Care approach for achieving health for all.

SUGGESTED MODIFICATIONS IN DISTRICT HEALTH SET-UP

The District level organization varies from State to State. The Mukherjee Committee¹¹ made the following recommendations:

1. The district head for both the curative and preventive services should be called the Chief Medical Officer of Health (CMOH), who should be assisted by two Deputy CMOHs, one for supervision of general health work in the district and the other for MCH and family planning.
2. An administrative officer from junior civil service cadre should be appointed to look after nontechnical work in the office of the CMOH.
3. The district hospital should have a Medical Superintendent. It should have all specialities and services and should serve as a referral center for basic health services in the district.
4. Nursing Supervisor, Health Supervisor and Public Health Engineer should be appointed at the district level.

Health organization in the Block is constituted by the Primary Health Center which renders integrated curative and preventive services. It is described in Chapter 28.

NEW INITIATIVE IN HEALTH CARE DELIVERY SYSTEM

Government of India will handover the running of the rural job scheme to a nationwide network of NGOs, sidelining the panchayats and Gram Sabhas that managed the program till now. Failure of local level political system with allegation of corruption and inefficiency has led to this. Many NGOs had been monitoring the National Rural Employment Guarantee Scheme but now they will be paid for their work. According to a draft note prepared by the rural development ministry, the NGO will spread awareness about the scheme, train the workforce, monitor the muster rolls and all documents relating to the work done, ensure that grievances are redressed and finally evaluate the scheme's implementation. The Panchayats will be kept in the loop but will no longer be the decision

makers. In the first phase, expected to start in a couple of months, the 'NGOization' will be implemented in 14 states. To start with, the voluntary organizations will be assigned just one district each and only for 6 months. Each NGO will be paid Rs. 4 lakh for these 6 months, for that Rs. 15 crore has been set aside in the financial year 2009-10.

Later on, NGOs will be involved in other major schemes such as the Indira Awas Yojana, Prime Minister's Gram Sadak Yojana and the Swarnajayanti Gram Swarozgar Yojana.

DISABILITY RULE

The Government has decided to simplify the process of issuing disability certificates to the disadvantaged people of rural areas.

- Primary health centers to provide disability certificates to those with visible disabilities such as blindness, amputations and paralysis of limbs.
- Those with complex disabilities will have to get certificates from district medical boards.
- Government to hold camps for issuing disability certificate at taluka/block level.
- Principals/headmasters of schools to arrange for certificates for students with disabilities.

National Health Policy

The Government of India adopted a National Health Policy in August 1983. India is one of the few countries in the world to have come out with a national policy on health. In view of its importance, it needs to be described in some detail. The policy is a 17-page document consisting of 20 paras and an appendix setting the goals for health and family welfare programs. These goals are given in **Table 26.9**. An abridged parawise description of the policy is given below:

PARA 1: INTRODUCTORY

The Constitution directs the State to regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health among its primary duties. It is felt that an integrated, comprehensive approach towards the future development of medical education, research and health services requires to be established to serve the actual health needs and priorities of the country. It is in this context that the need has been felt to evolve a National Health Policy.

PARA 2: OUR HERITAGE

"India has a rich heritage of medical and health sciences. The approach of our ancient medical systems was of a holistic nature."

TABLE 26.9: Goals for Health and Family Welfare Programs (as quoted in National Health Policy) vis-a-vis achievements

Sl. No	Indicator	Level as quoted in NHP	Goals			Achievements		Latest available	Ref. No.
			1985	1990	2000	1985	1990		
1	2	3	4	5	6	7	8	9	10
1.	Infant mortality rate								
	Rural	136(1978)	122			107	86	77 (1991)	29
	Urban	70(1978)	60			59	51	45 (1999)	29
	Combined	125(1978)	106	87	below 60	97	80	70 (1991)	29
2.	Perinatal mortality	67(1976)			30-35	53.8	49.6	44.2 (1993)	6
3.	Crude death rate	Around 14	12	10.4	9.0	11.7	9.6	8.7 (1991)	29
4.	Pre-school child (1-5 Years) mortality	24(1976-77)	20-24	15-20	10			10.5	20
5.	Maternal mortality rate	4-5(1976) 3-4	3-4	2-3	below 2			4.07 (1998)	29
6.	Life expectancy at birth (yr)								
	Male	52.6(1976-81)	55.1	57.6	64	58.1	58.1(1986-91)	62.4 (1996-01)	29
	Female	51.6(1976-81)	54.3	57.1	64	59.1	59.1(1986-91)	63.4 (1996-01)	29
7.	Babies with birth weight below 2500 gm (percentage)	30	25	18	10			—	—
8.	Crude birth rate	Around 35	31	27.0	21.0	32.7	29.9	26.1 (1999)	29
9.	Effective couple protection (percentage)	23.6 (March, 82)	37.0	42.0	60.0	37.5	44.1	46.2 (1999)	29
10.	Net reproduction rate(NRR)	1.48 (1981)	1.34	1.17	1.00				
11.	Growth rate (annual)	2.24 (1971-81)	1.90	1.66	1.20	2.24	2.03	1.8	20
12.	Family size	4.4 (1975)	3.8	2.3	4.4	4.0(1988)		3.5 (1993)	6
13.	Pregnant mothers receiving antenatal care(%)	40-50	50-60	60-75	100	40-50	60(1988)	—	—
14.	Deliveries by trained birth attendants(%)	30-35	50	80	100	30-35	40-50(1988)	48.8 (1993)	6
15.	Immunization status (% coverage)								
	TT (for pregnant women)	20	60	100	100	80.6	78.16	79.0 (1999)	29
	TT (for school children)								
	10 years		40	100	100	82.0	60.5	61.1 (1994-95)	6
	16 years	20	60	100	100	92.7	86.45	52.2 (1992-95)	6
	DPT (children below 3 years)	25	70	85	85	96.2	98.19	95.3 (1999)	29
	Polio (infants)	5	50	70	85	93.9	98.86	95.9 (1999)	29
	BCG (infants)	65	70	80	85	47.3	101.51	101.6 (1999)	29
	DT (new school entrants 5-6 years)	20	80	85	85	112.0	82.0	73.3 (1994-95)	6
	Typhoid (new school entrants 5-6 years)	2	70	85	85	70.3	62.6(1987-88)	—	—
16.	leprosy-percentage of disease arrested cases out of those detected	20	40	40	80	20	24.46	96 (1995)	6
17.	TB percentage of disease arrested cases out of those detected	50	60	75	90	50	66	72 (1992)	6
18.	Blindness-incidence of (%)	1.4	1	0.7	0.3	—	—	—	—

Source: NHP = National Health Policy^{6,20,29}

Note:

- The Planning Commission set the following goals in addition to the above³⁰

Vitamin A distribution	1985	1990	2000
Iron folic acid distribution to children up to 12 years	50%	50%	50%
Population with protected water supply			
Rural	60%	100%	100%
Urban	90%	100%	100%
Population with safe human excreta disposal			
Rural	10%	25%	100%
Urban	60%	80%	100%
Malaria API	2.7	1.9	Below 0.5
Goiter reduction	50%	75%	95%

- According to the seventh plan document, the target date for achieving net reproduction rate of 1 was 2000 AD. This has been now targeted for 2011-2016.
- Measles immunization coverage in 1999 was 89.6%

PARA 3: PROGRESS ACHIEVED

Since independence, considerable progress has been achieved, especially in reference to smallpox, plague and cholera. Mortality has decreased from 27.4 to 14.8 and life expectancy at birth has increased from 32.7 to over 52.

PARA 4: THE EXISTING PICTURE

The demographic and health picture of the country constitutes a cause for serious and urgent concern, with special reference to the following:

- High rate of population growth.
- High mortality rates for women, children and infants.
- Malnutrition.
- High prevalence of communicable and noncommunicable diseases, especially diarrheal diseases, leprosy, tuberculosis and blindness.
- Poor access of rural population to potable water supply (31%) and basic sanitation 0.5 percent.
- Poverty.
- Ignorance.
- Almost wholesale adoption of health manpower development policies based on the Western models, resulting in the development of a cultural gap between the people and the personnel providing care.
- Establishment of curative centers based upon Western models, which are inappropriate and irrelevant to the real needs of our people and their socio-economic condition.
- Emphasis on hospital based, cure oriented approach and neglect of preventive, promotive, public health and rehabilitative aspects of health care.
- Failure to involve the community in the identification of health needs and priorities, as well as in implementation and management of various health related programs.

PARA 5: NEED FOR EVOLVING A HEALTH POLICY—THE REVISED 20-POINT PROGRAM

India is committed to attaining the goal of “*Health for All by the year 2000 AD*” through the universal provision of comprehensive primary health care services. The attainment of this goal requires a thorough overhaul of the existing approaches to the education and training of medical and health personnel and the reorganization of the health services infrastructures. Furthermore, considering the large variety of inputs into health, it is necessary to secure the complete integration of all plans for health and human development with the overall national socioeconomic development process, specially in the more closely health related sectors, e.g. drugs and pharmaceuticals, agriculture and food production, rural development, education and social welfare, housing, water supply and sanitation,

prevention of food adulteration, maintenance of prescribed standards in the manufacture and sale of drugs and the conservation of the environment. In sum, the contours of the National Health Policy have to be evolved within a fully integrated planning framework which seeks to provide universal, comprehensive primary health care services, relevant to the actual needs and priorities of the community at a cost which the people can afford, ensuring that the planning and implementation of the various health programs is through the organized involvement and participation of the community, adequately utilizing the services being rendered by private voluntary organizations active in the health sector.

It is also necessary to ensure that the pattern of development of the health services infrastructure in the future fully takes into account the revised 20-point Program. The said program attributes very high priority promotion of family planning as a people’s program on a voluntary basis; substantial augmentation and provision of primary health care facilities on a universal basis; control of leprosy, TB and blindness; acceleration of welfare programs for women and children; nutrition programs for pregnant women, nursing mothers and children, especially in the tribal, hill and backward areas. The program also places high emphasis on the supply of drinking water to all problem villages, improvements in the housing and environments of the weaker sections of society; increased production of essential food items; integrated rural development; spread of universal elementary education; expansion of the public distribution system, etc.

PARA 6: POPULATION STABILIZATION

Improvement in health status of people cannot be achieved without achieving success in “securing the small family norm, through voluntary efforts and moving towards the goal of population stabilization. It is necessary to enunciate, separately, a National Population Policy.”

PARA 7: MEDICAL AND HEALTH EDUCATION

“The effective delivery of health care services would depend very largely on the nature of education, training and appropriate orientation towards community health of all categories of medical and health personnel and their capacity to function as an integrated team. Towards this end, it is necessary to formulate, separately, a National Medical and Health Education Policy which:

- Sets out the changes required to be brought about in the curricular contents and training program of medical and health personnel, at various levels of functioning.
- Takes into account the need for establishing the extremely essential interrelations between functionaries of various grades.

- Provides guidelines for the production of health personnel on the basis of realistically assessed manpower requirements.
- Seeks to resolve the existing sharp regional imbalances in their availability.
- Ensures that personnel at all levels are socially motivated towards the rendering of community health services.”

PARA 8: NEED FOR PROVIDING PRIMARY HEALTH CARE WITH SPECIAL EMPHASIS ON THE PREVENTIVE, PROMOTIVE AND REHABILITATIVE ASPECTS

There is disproportionate emphasis on the establishment of curative centers, the large majority of which are located in the urban areas of the country. *It is urgently necessary to restructure the health services within the following broad approach:*

- A well dispersed network of comprehensive primary health care services with the organized support of volunteers, auxiliaries, paramedics and adequately trained multipurpose workers. Services of private, voluntary organizations active in the health field require to be utilized in an integrated manner.
- The establishment of the primary health care approach would involve large scale transfer of knowledge, simple skills and technologies to Health Volunteers selected by the communities and enjoying their confidence. The quality of training of these health guides/workers would be of crucial importance to the success of this approach.
- The success of the decentralized primary health care system would depend vitally on the organized building up of individual self-reliance and effective community participation; on the provision of organized back-up support of the secondary and tertiary levels of the health care services, providing adequate logistical and technical assistance.
- The decentralization of services would require the establishment of a well worked out referral system to provide adequate expertise nearest to the community.
- It is necessary to establish a nationwide chain of sanitary-cum-epidemiological stations. The location and functioning of these stations may be between the primary and secondary levels of the hierarchical structure, depending upon the local situations and other relevant considerations. Each such station would require to have suitably trained staff equipped to identify, plan and provide preventive, promotive and mental health care services. It would be beneficial, depending upon the local situations, to establish such stations at the Primary Health centers. The district health organization should have, as an integral part of its set-up, a well organized epidemiological unit to coordinate and superintend the functioning of the field stations. These stations would participate in the integrated action plans to eradicate and control diseases, besides tackling specific local environmental health problems.
- The location of curative centers should be related to the populations they serve, keeping in view the densities of population, distances, topography and transport connections. These centers should function within the recommended referral system. To maximize the utilization of available resources, new and additional curative centers should be established only in exceptional cases, the basic attempt being towards the upgradation of existing facilities. Expenditure on curative centers should be reduced as much as possible.
- With a view to reducing governmental expenditure and fully utilizing untapped resources, planned programs may be devised, related to the local requirements and potentials, to encourage the establishment of practice by private medical professional, increased investment by nongovernmental agencies in establishing curative centers and by offering organized logistical, financial and technical support to voluntary agencies in the health field.
- While the major focus of governmental efforts would be upon primary health care and public health services, specialty and superspecialty services also need to be provided. To reduce governmental expenditures involved in the establishment of such centers, planned efforts should be made to encourage private investments in such fields so that the majority of such centers, within the governmental set-up, can provide adequate care and treatment to those entitled to free care, the affluent sectors being looked after by the paying clinics.
- Special, well-coordinated programs should be launched to provide mental health care as well as medical care and the physical and social rehabilitation of those who are mentally retarded, deaf, blind, physically disabled, infirm and the aged. Also, suitably organized programs would require to be launched to ensure the prevention of various disabilities.
- In the establishment of the reorganized services, the first priority should be accorded to provide services to those residing in the tribal, hill and backward areas as well as to endemic disease affected populations and the vulnerable sections of the society.
- In the reorganized health services scheme, efforts should be made to ensure adequate mobility of personnel at all levels of functioning.
- In the various approaches, set out in (1) to (11) above, organized efforts would require to be made to fully utilize and assist in the enlargement of the services being provided by private voluntary organizations active in the health field.

PARA 9: REORIENTATION OF THE EXISTING HEALTH PERSONNEL

A dynamic process of change and innovation is required to be brought about in the entire approach to health manpower development, ensuring the emergence of fully integrated bands of workers functioning within the “Health Team” approach.

PARA 10: PRIVATE PRACTICE BY GOVERNMENTAL FUNCTIONARIES

It is desirable for the States to take steps to phase out the system of private practice by medical personnel in government service, providing at the same time for payment of appropriate compensatory nonpractising allowance.

PARA 11: PRACTITIONERS OF INDIGENOUS AND OTHER SYSTEMS OF MEDICINE AND THEIR ROLE IN HEALTH CARE

The country has a large stock of health manpower comprising private practitioners in various systems, for example, Ayurveda, Unani, Sidha, Homeopathy, Yoga, Naturopathy, etc. This resource has not so far been adequately utilized. The practitioners of these various systems enjoy high local acceptance and respect and consequently exert considerable influence on health beliefs and practices. It is, therefore, necessary to initiate organized measures to enable each of these various systems of medicine and health care to develop in accordance with its genius. Simultaneously, planned efforts should be made to dovetail the functioning of the practitioners of these various systems and integrate their services, at the appropriate levels, within specified areas of responsibility and functioning, in the overall health care delivery system, specially in regard to the preventive, promotive and public health objectives. Well considered steps would also require to be launched to move towards a meaningful, phased integration of the indigenous and the modern systems.

PARA 12: PROBLEMS REQUIRING URGENT ATTENTION

Nutrition: Adequate nutrition for all segments of the population through a well-developed distribution system, specially in the rural areas and urban slums, should be ensured. The overall strategy would necessarily involve organized efforts at improving the purchasing power of the poorer sections of the society. Schemes like employment guarantee scheme, to which the government is committed, could yield optimal results. Measures should be taken to improve dietary practices and to promote breastfeeding. Supplementary feeding programs directed to the vulnerable sections of the population should be arranged in chronically malnourished communities.

Prevention of food adulteration and maintenance of the quality of drugs.

Water Supply and Sanitation: The provision of safe drinking water and sanitary disposal of waste waters, human and animal wastes, both in urban and rural areas, must constitute an integrated package.

Environmental Protection: It would be necessary to ensure against the haphazard exploitation of resources which cause ecological disturbances leading to fresh health hazards. Environmental appraisal procedure must be developed and strictly applied in according clearance to the various industrial and developmental projects.

Immunization Program: (Chapter 30)

Maternal and Child Health Services: A vicious relationship exists between high birth rates and high infant mortality, contributing to the desire for more children. The highest priority would, therefore, require to be devoted to efforts of launching special programs for the improvement of maternal and child health, with a special focus on the less privileged sections of society. While efforts should continue at providing refresher training and orientation to the traditional birth attendants, schemes and programs should be launched to ensure that progressively all deliveries are conducted by competently trained persons.

School Health Program: (Chapter 32)

Occupational Health Services: There is urgent need for launching well-considered schemes to prevent and treat diseases and injuries arising from occupational hazards, not only in the various industries but also in the comparatively unorganized sectors like agriculture.

PARA 13: HEALTH EDUCATION

The recommended efforts, on various fronts, would bear only marginal results unless nationwide health education programs, backed by appropriate communication strategies, are launched to provide health information in easily understandable form, to motivate the development of an attitude for healthy living. The public health education programs should be supplemented by health, nutrition and population education programs in all educational institutions at various levels. Simultaneously, efforts would require to be made to promote universal education, specially adult and family education, without which the various efforts to organize preventive and promotive health activities, family planning and improved maternal and child health cannot bear fruit.

PARA 14: MANAGEMENT INFORMATION SYSTEM

Appropriate decision making and program planning in the health and related fields is not possible without establishing an effective health information system.

PARA 15: MEDICAL INDUSTRY

The country has built up sound technological and manufacturing capability in the field of drugs, vaccines, biomedical equipments, etc. The available know how requires to be adequately exploited to increase the production of essential and life saving drugs and vaccines of woven quality to fully meet the national requirement, specially in regard to the national programs to combat Malaria, TB, Leprosy, Blindness, Diarrheal diseases, etc. The production of the essential, life-saving drugs under their generic names and the adoption of economical packaging practices would considerably reduce the unit cost of medicines, bringing them within the reach of the poorer sections of society, besides significantly reducing the expenditure being incurred by the governmental organization on the purchase of drugs. In view of the low cost of indigenous and herbal medicines, organized efforts may be launched to establish herbal gardens, producing drugs of certified quality and making them easily available.

The practitioners of the modern medical system rely heavily on diagnostic aids involving extensive use of costly, sophisticated biomedical equipment. Effective mechanisms should be established to identify essential equipments required for extensive use and to promote and enlarge their indigenous manufacture, for such devices being readily available, at reasonable prices, for use at the health care centers.

PARA 16: HEALTH INSURANCE

It would be necessary to devise well-considered health insurance schemes, on a Statewise basis, for mobilizing additional resources for health promotion and ensuring that the community shares the cost of the services, in keeping with its paying capacity.

PARA 17: HEALTH LEGISLATION

It is necessary to urgently review all existing legislation and work towards a unified, comprehensive legislation in the health field, enforceable all over the country.

PARA 18: MEDICAL RESEARCH

Special attention should be paid to:

- Containment and eradication of the existing, widely prevalent diseases
- Translation of available know how into simple, low cost, appropriate technologies
- Applied operational research for improving cost effective delivery of health services
- More effective treatment and preventive procedures for blindness, leprosy and TB
- Contraceptive research
- Nutrition research.

PARA 19: INTERSECTORAL COOPERATION

It is necessary to secure intersectoral coordination of the various efforts in the fields of health and family planning, medical education and research, drugs and pharmaceuticals, agriculture and food, water supply and drainage, housing, education and social welfare and rural development.

PARA 20: MONITORING AND REVIEW OF PROGRESS

It would be of crucial importance to monitor and periodically review the success of the efforts made and the results achieved in reference to the goals set out in the annexure.

Comments about National Health Policy

The Health Policy is a valuable document and provides a clear framework for national health planning. However, it has been criticized on the following grounds.²⁵

- The policy talks of poverty alleviation, (e.g. through the minimum needs program), as a necessary precondition of Health for All. However, the policy does not speak even once about social justice (in health and in other fields such as land reforms and wages), which is an essential prerequisite for Health for All.
- No definite program has been suggested for promoting community participation in health.
- The policy is totally silent about health budget, the meagreness of which has already been explained **Table 26.8**.
- The Health Policy is not an integral part of a broad movement of radical redistribution of economic assets and political power, and of deep transformation of ideas, attitudes and values, which are essential for achieving Health for All by 2000 AD. This is because the Health for All is intimately linked with eradication of poverty, ignorance and inequality.
- It is either silent or does not give adequate emphasis to certain areas such as accident prevention, geriatric care and prevention of noncommunicable diseases like obesity, coronary heart disease and diseases related to use of tobacco, alcohol, drugs, etc.

REVISED DRAFT NATIONAL POLICY

It has been generally felt that the National Health Policy needs to be revised. The Ministry of Health and Family Welfare has prepared a draft of the revised policy. It has yet to be approved by the government, including the Ministry of Finance, and finally, by the parliament. The Draft Policy is given below. It can be accessed at www.mohfw.nic.in/np2001.htm.

National Health Policy-2001

INTRODUCTORY

A National Health Policy was last formulated in 1983 and since then, there have been very marked changes in the determinant factors relating to the health sector. Some of the policy initiatives outlined in the NHP-1983 have yielded results, while in several other areas, the outcome has not been as expected.

The NHP-1983 gave a general exposition of the recommended policies required in the circumstances then prevailing in the health sector. The noteworthy initiatives under that policy were:

- A phased, time-bound program for setting up a *well-dispersed* network of comprehensive primary health care services, linked with extension and health education, designed in the context of the ground reality that elementary health problems can be resolved by the people themselves.
- Intermediation through ‘*Health Volunteer*’ having appropriate knowledge, simple skills and requisite technologies.
- Establishment of a well-worked out *referral system* to ensure that patient load at the higher levels of the hierarchy is not needlessly burdened by those who can be treated at the decentralized level.
- An integrated network of evenly spread speciality and superspeciality services; encouragement of such facilities through *private investments* for patients who can pay, so that the draw on the Government’s facilities is limited to those entitled to free use.

Government initiatives in the Public Health Sector have recorded some noteworthy successes overtime. Smallpox and Guinea Worm Disease have been eradicated from the country; Polio is on the verge of being eradicated; Leprosy, Kala-azar, and Filariasis can be expected to be eliminated in the foreseeable future. There has been a substantial drop in the Total Fertility Rate and Infant Mortality Rate. The success of the initiatives taken in the public health field are reflected in the progressive improvement of many demographic/epidemiological/infrastructural indicators overtime (**Table 26.10**).

While noting that the Public Health Initiatives over the years have contributed significantly to the improvement of these health indicators, it is to be acknowledged that public health indicators/disease-burden statistics are the outcome of several complementary initiatives under the wider umbrella of the developmental sector, covering Rural Development, Agriculture, Food Production, Sanitation, Drinking Water Supply, Education, etc. Despite the impressive public health gains as revealed in the statistics in **Table 26.10**, there is no gain saying the fact that the morbidity and mortality levels in the country are the unacceptably high. These unsatisfactory health

indices are, in turn, an indicator of the limited success of the public health system to meet the preventive and curative requirements of the general population.

Out of the communicable diseases, which have persisted over history, incidence of Malaria has staged a resurgence in the 1980s before stabilizing at a fairly high prevalence level during the 1990s. Over the years, an increasing level of insecticide-resistance has developed in the malarial vectors in many parts of the country, while the incidence of the more deadly *P. falciparum* malaria has risen to about 50 percent in the country as a whole. In respect of TB, the public health scenario has not shown any significant decline in the pool of infection amongst the community, and, there has been a distressing trend in increase of drug resistance in the type of infection prevailing in the country. A new and extremely virulent communicable disease—*HIV/AIDS*—has emerged on the health scene since the declaration of the NHP-1983. As there is no existing therapeutic cure or vaccine for this infection, the disease constitutes a serious threat, not merely to public health but to economic development in the country. The common waterborne infections—gastro-enteritis, cholera, and some forms of Hepatitis—continue to contribute to a high level of morbidity in the population, even though the mortality rate may have been somewhat moderated. The period after the announcement of NHP-83 has also seen an increase in mortality through ‘*lifestyle*’ diseases—diabetes, cancer and cardiovascular diseases. The increase in life expectancy has increased the *requirement for geriatric care*. Similarly, the increasing burden of trauma cases is also

TABLE 26.10: Through the years—1951-2000 achievements

Indicator	1951	1981	2000
<i>Demographic Changes</i>			
Life Expectancy	36.7	54	64.6 (RGI)
Crude Birth Rate	40.8	33.9 (SRS)	26.1 (99 SRS)
Crude Death Rate	25	12.5 (SRS)	8.7 (99 SRS)
IMR	146	110	70 (99 SRS)
<i>Epidemiological shifts</i>			
Malaria (cases in million)	75	2.7	2.2
Leprosy cases per 10,000 population	38.1	57.3	3.74
Smallpox (no of cases)	> 44,887	Eradicated	
Guinea worm (no of cases)		> 39,792	Eradicated
Polio		29709	265
<i>Infrastructure</i>			
SC/PHC/CHC	725	57,363	1,63,181 (99-RHS)
Dispensaries and Hospitals (all)	9209	23,555	43,322 (95-96-CBHI)
Beds (Pvt and Public)	117,198	569,495	8,70,161 (95-96-CBHI)
Doctors (Allopathy)	61,800	2,68,700	5,03,900 (98-99-MCI)
Nursing Personnel	18,054	1,43,887	7,37,000 (99-INC)

a significant public health problem. The changed circumstances relating to the health sector of the country since 1983 have generated a situation in which it is now necessary to review the field, and to formulate a new policy framework as the National Health Policy-2001.

NHP-2001 will attempt to set out a new policy framework for the accelerated achievement of Public health goals in the socioeconomic circumstances currently prevailing in the country.

CURRENT SCENARIO

Financial Resources

The *public health investment* in the country over the years has been comparatively low, and as a *percentage of GDP* has declined from 1.3 percent in 1990 to 0.9 percent in 1999. The *aggregate expenditure in the Health sector* is 5.2 percent of the GDP. Out of this, *about 20 percent* of the aggregate expenditure is *public health spending*, the balance being out of pocket expenditure. The *central budgetary allocation* for health over this period, as a percentage of the total Central Budget, has been *stagnant at 1.3 percent*, while that *in the States has declined from 7.0 percent to 5.5 percent*. The *current annual per capita public health expenditure* in the country is no more than Rs.160. Given these statistics, it is no surprise that the reach and quality of public health services has been below the desirable standard. Under the constitutional structure, *public health is the responsibility of the States*. In this framework, it has been the expectation that the principal contribution for the funding of public health services will be from States' resources, with some supplementary input from Central resources. In this backdrop, *the contribution of Central resources to the overall public health funding has been limited to about 15 percent*. The fiscal resources of the State Governments are known to be very inelastic. This itself is reflected in the declining percentage of State resources allocated to the health sector out of the State Budget. If the decentralized public health services in the country are to improve significantly, there is a need for injection of substantial resources into the health sector from the Central Government Budget. This approach, despite the formal constitutional provision in regard to public health a necessity if the State public health services—a major component of the initiatives in the social sector—are not to become entirely moribund. The NHP-2001 has been formulated taking into consideration these ground realities in regard to the availability of resources.

Equity

In the period when centralized planning was accepted as a key instrument of development in the country, the attainment of an equitable regional distribution was

considered one of its major objectives. Despite this conscious focus in the development process, the statistics given in **Table 26.11** clearly indicate that attainment of health indices have been very *uneven, across the rural-urban divide*.

Also, the statistics bring out the wide differences between the attainments of health goals in the better-performing States as compared to the low-performing States. It is clear that national averages of health indices hide wide disparities in public health facilities and health standards in different parts of the country. Given a situation in which national averages in respect of most indices are themselves at unacceptably low levels, the wide interstate disparity implies that, for vulnerable sections of society in several states, access to public health services is nominal and health standards are grossly inadequate. Despite a thrust in the NHP-1983 for making good the unmet needs of public health services by establishing more public health institutions at a decentralized level, a large gap in facilities still persists. Applying current norms to the population projected for the year 2000, it is estimated that the shortfall in the number of SCs/PHCs/CHCs is of the order of 16 percent. However, this shortage is as high as 58 percent when disaggregated for CHCs only. The NHP-2001 will need to address itself to making good these deficiencies so as to narrow the gap between the various States, as also the gap across the rural-urban divide.

Access to and benefits from, the public health system have been very uneven between the better-endowed and the more vulnerable sections of society. This is particularly true for women, children and the socially disadvantaged sections of society. The statistics given in **Table 26.12** highlight the handicap suffered in the health sector on account of socioeconomic inequity.

It is a principal objective of NHP-2001 to evolve a policy structure which reduces these inequities and allows the disadvantaged sections of society a fairer access to public health services.

Delivery of National Public Health Programs

It is self-evident that in a country as large as India, which has a wide variety of socioeconomic settings, national health programs have to be designed with enough flexibility to permit the State public health administrations to craft their own program package according to their needs. Also, the implementation of the national health programme can only be carried out through the State Governments' decentralized public health machinery. Since, (or various considerations, the responsibility of the Central Government in funding additional public health services will continue over a period of time, the role of the Central Government in designing broad-based public health initiatives will inevitably continue. Moreover, it has been observed that the technical and managerial expertise for designing large-span public

TABLE 26.11: Differentials in health status among states

Sector	Population	IMR/per 100 Live births (1999 SRS)	< 5 Mortality per 1000 (NFHSH)	Weight for age % of children under 3 yrs (< -2 SD)	MMR/Lakh (Annual report 2000)	Leprosy cases per 10000 population	Malaria +ve cases in years 2000 (in thousands)
India	26.1	70	94.9	47	408	3.7	2200
Rural	27.09	75	103.7	49.6	—	—	—
Urban	23.62	44	63.1	38.4	—	—	—
<i>Better Performing States</i>							
Kerala	12.72	14	18.8	27	87	0.9	5.1
Maharashtra	25.02	48	58.1	50	135	3.1	138
TN	21.12	52	63.3	37	79	4.1	56
<i>Low Performing States</i>							
Orissa	47.15	97	104.4	54	498	7.05	483
Bihar	42.60	63	105.1	54	707	11.83	132
Rajasthan	15.28	81	114.9	51	607	0.8	53
UP	31.15	84	122.5	52	707	4.3	99
MP	37.43	90	137.6	55	498	3.83	528

TABLE 26.12: Differentials in health status among socioeconomic groups

Indicator	Infant Mortality/1000	Under 5 Mortality/1000	% Children Underweight
India	70	94.9	47
Social Inequity			
Scheduled Castes	83	119.3	53.5
Scheduled Tribes	84.2	126.6	55.9
Other Disadvantaged	76	103.1	47.3
Others	61.8	82.6	41.1

health programmes exists with the Central Government in a considerable degree; this expertise can be gainfully utilized in designing national health programmes for implementation in varying socioeconomic settings in the status.

Over the last decade or so, the Government has relied upon a 'vertical' implementational structure for the major disease control programs. Through this, the system has been able to make a substantial dent in reducing the burden of specific diseases. However, such an organizational structure, which requires independent manpower for each disease program, is extremely expensive and difficult to sustain. Over a long time-range, 'vertical' structures may only be affordable for diseases, which offer a reasonable possibility of elimination or eradication in a foreseeable time-span. In this background, the NHP-2001 attempts to define the role of the Central Government and the State Governments in the public health sector of the country.

The State of Public Health Infrastructure

The delineation of NHP-2001 would be required to be based on an objective assessment of the quality and efficiency of the existing public health machinery in the field. It would detract from the quality of the exercise

if, while framing a new policy, it is not acknowledged that the existing public health infrastructure is far from satisfactory. For the outdoor medical facilities in existence, funding is generally insufficient; the presence of medical and paramedical personnel is often much less than required by the prescribed norms; the availability of consumables is frequently negligible; the equipment in many public hospitals is often obsolescent and unusable; and the buildings are in a dilapidated state. In the indoor treatment facilities, again, the equipment is often obsolescent; the availability of essential drugs is minimal; the capacity of the facilities is grossly inadequate, which leads to overcrowding, and consequentially to a steep deterioration in the quality of the services. As a result of such inadequate public health facilities, it has been estimated that less than 20 percent of the population seeks the OPD services and less than 45 percent avails of the facilities for indoor treatment in public hospitals. This is despite the fact that most of these patients do not have the means to make out of pocket payments for private health services except at the cost of other essential expenditure for items such as basic nutrition.

Extending Public Health Services

While in the country generally there is a shortage of medical manpower, this shortfall is disproportionately impacted on the less-developed and rural areas. No incentive system attempted so far, has induced private medical manpower to go to such areas; and, even in the public health sector it has usually been a losing battle to deploy medical manpower in such under-served areas. In such a situation, the possibility needs to be examined for entrusting some limited public health functions to nurses, paramedics and other personnel from the extended health sector after imparting adequate training to them.

India has a vast reservoir of practitioners in the Indian Systems of Medicine and Homeopathy, who have undergone formal training in their own disciplines. The possibility of using such practitioners in the implementation of State/Central Government public health programmes, in order to increase the reach of basic health care in the country, is addressed in the NHP-2001.

Role of Local Self-Government Institutions

Some States have adopted a policy of devolving programs and funds in the health sector through different levels of the Panchayat Raj Institutions. Generally, the experience has been a favorable one. The adoption of such an organizational structure has enabled need-based allocation of resources and closer supervision through the elected representatives. NHP-2001 examines the need for wider adoption of this mode of delivery of health services, in rural as well as urban areas, in other parts of the country.

Medical Education

Medical Colleges are not evenly spread across various parts of the country. Apart from the uneven geographical distribution of medical institutions, the quality of education is highly uneven and in several instances even substandard. It is a common perception that the syllabus is excessively theoretical, making it difficult for the fresh graduate to effectively meet even the primary health care needs of the population. There is an understandable reluctance on the part of graduate doctors to serve in areas distant from their native place. NHP-2001 will suggest policy initiatives to rectify these disparities.

Certain medical discipline, such as, molecular biology and gene manipulation, have become relevant in the period after the formulation of the previous National Health Policy. Also, certain specialty disciplines—anesthesiology, radiology and forensic medicines are currently very scarce, resulting in critical deficiencies in the package of available public health services. The components of medical research in the recent years have changed radically. In the foreseeable future such research will rely increasingly on such new disciplines. It is observed that the current undergraduate medical syllabus does not cover such emerging subjects. NHP-2001 will make appropriate recommendations in this regard.

Need for Specialists in 'Public Health' and 'Family Medicine'

In any developing country with inadequate availability of health services, the requirement of expertise in the areas of 'public health' and 'family medicine' is very much more than the expertise required for other specialized clinical disciplines. In India, the situation is that public

health expertise is nonexistent in the private health sector, and far short of requirement in the public health sector. Also, the current curriculum in the graduate/postgraduate courses is outdated and unrelated to contemporary community needs. In respect of 'family medicine', it needs to be noted that the more talented medical graduates generally seek specialization in clinical disciplines, while the remaining go into general practice. While the availability of postgraduate educational facilities is 50 percent of the total number of the qualifying graduates each year and can be considered adequate, the distribution of the disciplines in the postgraduate training facilities is overwhelmingly in favor of clinical specializations. NHP-2001 examines the need for ensuring adequate availability of personnel with specialization in the 'public health' and 'family medicine' disciplines, to discharge the public health responsibilities in the country.

Urban Health

In most urban areas, public health services are very meagre. To the extent that such services exist, there is no uniform organizational structure. The urban population in the country is presently as high as 30 percent and is likely to go up to 1 around 33 percent by 2010. The bulk of the increase is likely to take place through migration, resulting in slums without any infrastructure support. Even the meagre public health services available do not percolate to such unplanned habitations, forcing people to avail of private health care through out of pocket expenditure. The rising vehicle density in large urban agglomerations has also led to an increased number of serious accidents requiring treatment in well-equipped trauma centers. NHP-2001 will address itself to the need for providing this unserved population a minimum standard of health care facilities.

Mental Health

Mental health disorders are actually much more prevalent than are visible on the surface. While such disorders do not contribute significantly to mortality, they have a serious bearing on the quality of life of the affected persons and the families. Serious cases of mental disorder require hospitalization and treatment under trained supervision. Mental health institutions are perceived to be woefully deficient in physical infrastructure and trained manpower. NHP-2001 will address itself to these deficiencies in the public health sector.

Information, Education and Communication

A substantial component of primary health care consists of initiatives for disseminating, to the citizenry, public health-related information. Public health programs, particularly, need high visibility at the decentralized level in order to have any impact. This task is particularly

difficult as 35 percent of our country's population is illiterate. The present IEC strategy is too fragmented, relies heavily of mass media and does not address the needs of this segment of the population. It is often felt that the effectiveness of IEC programs is difficult to judge; and consequently, it is often asserted that accountability, in regard to the productive use of such funds, is doubtful. NHP-2001, while projecting an IEC strategy, will fully address the inherent problems encountered in any IEC program designed for improving awareness in order to bring about behavioral change in the general population.

It is widely accepted that school and college students are the most receptive targets for imparting information relating to basic principles of preventive health care. NHP-2001 will attempt to target this group to improve the general level of health awareness.

Medical Research

Over the years, medical research activity in the country has been very limited. In the Government, such research has been confined to the research institutions under the Indian Council of Medical Research, and other institutions funded by the States/Central Government. Research in the private sector has assumed some significance only in the last decade. In our country, where the aggregate annual health expenditure is of the order of Rs. 80,000 crores, the expenditure in 1998-99 on research, both public and private sectors, was only of the order of Rs. 1150 crores. It would be reasonable to infer that with such low research expenditure, it would be virtually impossible to make any dramatic breakthrough within the country, by way of new molecules and vaccines; also, without a minimal back-up of applied and operational research, it would be difficult to assess whether the health expenditure in the country is being incurred through optimal applications and appropriate public health strategies. Medical research in the country needs to be focused on therapeutic drugs/vaccines for tropical diseases, which are normally neglected by international pharmaceutical companies on account of limited profitability potential. The thrust will need to be in the newly emerging frontier areas of research based on genetics, genome-based drug and vaccine development, molecular biology, etc. NHP-2001 will address these inadequacies and spell out a minimal quantum of expenditure for the coming decade, looking to the national needs and the capacity of the research institutions to absorb the funds.

Role of the Private Sector

Considering the economic restructuring underway in the country, and over the globe, since the last decade, the changing role of the private sector in providing health care will also have to be addressed in NHP-2001.

Currently, the contribution of private health care is principally through independent practitioners. Also, the private sector contributes significantly to secondary-level care and some tertiary care. With the increasing role of private health care, the need for statutory licensing and monitoring of minimum standards of diagnostic centers/medical institutions becomes imperative. NHP-2001 will address the issues regarding the establishment of a regulatory mechanism to ensure adequate standards of diagnostic centers/medical institutions, conduct of clinical practice and delivery of medical services.

Currently, nongovernmental service providers are treating a large number of patients at the primary level for major diseases. However, the treatment regimens followed are diverse and not scientifically optimal, leading to an increase in the incidence of drug resistance. NHP-2001 will address itself to recommending arrangements, which will eliminate the risks arising from inappropriate treatment.

The increasing spread of information technology raises the possibility of its adoption in the health sector. NHP-2001 will examine this possibility.

Role of the Civil Society

Historically, the practice has been to implement major national disease control programs through the public health machinery of the State/Central Governments. It has become increasingly apparent that certain components of such programs cannot be efficiently implemented merely through government functionaries. A considerable change in the mode of implementation has come about in the last two decades, with an increasing involvement of NGOs and other institutions of civil society. It is to be recognized that widespread debate on various public health issues have, in fact, been initiated and sustained by NGOs and other members of the civil society. Also, an increasing contribution is being made by such institutions, in the delivery of different components of public health services. Certain disease control programs require close interaction with the beneficiaries for regular administration of drugs; periodic carrying out of the pathological tests; dissemination of information regarding disease control and other general health information. NHP-2001 will address such issues and suggest policy instruments for implementation of public health programs through individuals and institutions of civil society.

National Disease Surveillance Network

The technical network available in the country for disease surveillance is extremely rudimentary and to the extent that the system exists, it extends only up to the district level. Disease statistics are not flowing through an integrated network from the decentralized public health

facilities to the State/Central Government health administration. Such an arrangement only provides belated information, which, at best, serves a limited statistical purpose. The absence of an efficient disease surveillance network is a major handicap in providing a prompt and cost-effective health care system. The efficient disease surveillance network set-up for Polio and HIV/AIDS has demonstrated the enormous value of such a public health instrument. Real time information of focal outbreaks of common communicable diseases—Malaria, GE, Cholera and JE and other seasonal trends of diseases, would enable timely intervention, resulting in the containment of any possible epidemic. In order to be able to use an integrated disease surveillance network, for operational purposes, realtime information is necessary at all levels of the health administration. NHP-2001 would address itself to this major systemic shortcoming in the administration.

Health Statistics

The absence of a systematic and scientific health statistics database is a major deficiency in the current scenario. The health statistics collected are not the product of a rigorous methodology. Statistics available from different parts of the country, in respect of major diseases, are often not obtained in a manner which make aggregation possible, or meaningful.

Further, absence of proper and systematic documentation of the various financial resources used in the health sector is another lacunae witnessed in the existing scenario. This makes it difficult to understand trends and levels of health spending by private and public providers of health care in the country, and to address related policy issues and formulate future investment policies.

NHP-2001 will address itself to the program for putting in place a modern and scientific health statistics database as well as a system of national health accounts.

Women's Health

Social, cultural and economic factors continue to inhibit women from gaining adequate access to even the existing public health facilities. This handicap does not just affect women as individuals; it also has an adverse impact on the health, general well-being and development of the entire family, particularly children. NHP-2001 recognises the catalytic role of empowered women in improving the overall health standards of the community.

Medical Ethics

Professional medical ethics in the health sector is an area, which has not received much attention in the past. Also, the new frontier areas of research involving gene manipulation, organ/human cloning and stem cell

research impinge on visceral issues relating to the sanctity of human life and the moral dilemma of human intervention in the designing of life forms. Besides these, in the emerging areas of research, there is an uncharted risk of creating new life forms, which may irreversibly damage the environment, as it exists today. NHP-2001 recognises that moral and religious dilemma of this nature, which was not relevant even two years ago, now pervades mainstream health sector issues.

Enforcement of Quality Standards for Food and Drugs

There is an increasing expectation and need of the citizenry for efficient enforcement of reasonable quality standards for food and drugs. Recognizing this need, NHP-2001 makes an appropriate policy recommendation.

Regulation of Standards in Paramedical Disciplines

It has been observed that a large number of training institutions have mushroomed particularly in the private sector, for several paramedical disciplines—laboratory technicians, radiodiagnosis technicians, physiotherapists, etc. Currently there is no regulation/monitoring of the curriculum, or the performance of the practitioners in these disciplines. NHP-2001 will make recommendations to ensure standardization of training and monitoring of performance.

Occupational Health

Work conditions in several sectors of employment in the country are substandard. As a result of this, workers engaged in such activities become particularly prone to occupation-linked ailments. The long-term risk of chronic morbidity is particularly marked in the case of child labour. NHP-2001 will address the risk faced by this particularly vulnerable section of the society.

Providing Medical Facilities to Users from Overseas

The secondary and tertiary facilities available in the country are of good quality and cost-effective compared to international medical facilities. This is true not only of facilities in the allopathic disciplines, but also to those belonging to the alternative systems of medicine, particularly Ayurveda. NHP-2001 will assess the possibilities of encouraging commercial medical services for patients from overseas.

Impact of Globalization on the Health Sector

There are some apprehensions about the possible adverse impact of economic globalization on the health sector. Pharmaceutical drugs and other health services have always been available in the country at extremely

inexpensive prices. India has established a reputation for itself around the globe for innovative development of original process patents for the manufacture of a wide range of drugs and vaccines within the ambit of the existing patent laws. With the adoption of **Trade Related Intellectual Property (TRIPS)**, and the subsequent alignment of domestic patent laws consistent with the commitments under TRIPS, there will be a significant shift in the scope of the parameters regulating the manufacture of new drugs/vaccines. Global experience has shown that the introduction of a TRIPS-consistent patent regime for drugs in a developing country, would result in an increase in the cost of drugs and medical services. NHP-2001 will address itself to the future imperatives of health security in the country, in the post-TRIPS era.

Non-health Determinants

Improved health standards are closely dependent on major nonhealth determinants such as safe drinking water supply, basic sanitation, adequate nutrition, clean environment and primary education, especially of the girl child. NHP-2001 will not explicitly address itself to the initiatives in these areas, which although crucial, fall outside the domain of the health sector. However, the attainment of the various targets set in NHP-2001 assumes a reasonable performance in these allied sectors.

Population Growth and Health Standards

Efforts made over the years for improving health standards have been neutralized by the rapid growth of the population. Unless the population stabilization goals are achieved, no amount of effort in the other components of the public health sector can bring about significantly better national health standards. Government has separately announced the 'National Population Policy-2000.' The principal common features covered under the National Population Policy-2000 and NHP-2001, relate to the *prevention and control of communicable diseases; priority to containment or HIV/AIDS infection; universal immunization of children against all major preventable diseases; addressing the unmet need for basic and reproductive health services; and supplementation of infrastructure.* The synchronized implementation of these two Policies-National Population Policy-2000 and National Health Policy-2001—will be the very cornerstone of any national structural plan to improve the health standards in the country.

Alternative Systems of Medicine

Alternative systems of medicine—Ayurveda, Unani, Siddha and Homeopathy—provide a significant supplemental contribution to the health care services in

the country, particularly in the undeserved, remote and tribal areas. The main components of NHP-2001 apply equally to the alternative systems of medicine. However, the policy features specific to the alternative systems of medicine will be presented as a separate document.

OBJECTIVES

The main objective of NHP-2001 is *to achieve an acceptable standard of good health amongst the general population of the country.* The approach would be to increase access to the decentralized public health system by establishing new infrastructure in deficient areas, and by upgrading the infrastructure in the existing institutions. Overriding importance would be given to ensuring a more equitable access to health services across the social and geographical expanse of the country. Emphasis will be given to increasing the aggregate public health investment through a substantially increased contribution by the Central Government. It is expected that this initiative will strengthen the capacity of the public health administration at the State level to render effective service delivery. The contribution of the private sector in providing health services would be much enhanced, particularly for the population group, which can afford to pay for services. Primacy will be given to preventive and first-line curative initiatives at the primary health level through increased sectoral share of allocation. Emphasis will be laid on rational use of drugs within the allopathic system. Increased access to tried and tested systems of traditional medicine will be ensured. Within these broad objectives, NHP-2001 will endeavor to achieve the time-bound goals mentioned in **Table 26.13.**

TABLE 26.13: Goals to be achieved by 2000–2015

• Eradicate polio and yaws	2005
• Eliminate leprosy	2005
• Eliminate kala-azar	2010
• Eliminate lymphatic filariasis	2015
• Achieve zero level growth of HIV/AIDS	2007
• Reduce mortality by 50 percent on account of TB, malaria and other vector and water-borne diseases	2010
• Reduce prevalence of blindness to 0.5 percent	2010
• Reduce IMR to 30/1000 and MMR to 100/lakh	2010
• Improve nutrition and reduce proportion of LBW babies from 30 percent to 10 percent	2010
• Increase utilisation of public health facilities from current level of < 20 to > 75 percent	2010
• Establish an integrated system of surveillance, National Health Accounts and Health Statistics	2005
• Increase health expenditure by Government as a percent of GDP from the existing 0.9 to 2.0 percent	2010
• Increase share of Central grants to Constituent at least 25 percent of total health spending	2010
• Increase State Sector Health spending from 5.5 to 7 percent of the budget	2005
• Further increase to 8 percent	2010

NHP-2001—POLICY PRESCRIPTIONS

Financial Resources

The paucity of public health investment is a stark reality. Given the extremely difficult fiscal position of the State Governments, the Central Government will have to play a key role in augmenting public health investments. Taking into account the gap in health care facilities under NHP-2001 *it is planned to increase health sector expenditure to 6 percent of GDP with 2 percent of GDP being contributed as public health investment, by the year 2010.* The State Governments would also need to increase the commitment to the health sector. In the first phase, by 2005, they would be expected to increase the commitment of their resources of 7 percent of the Budget; and, in the second phase, by 2010, to increase it to 8 percent of the Budget. With the stepping up of the public health investment, the Central Government's contribution would rise to 25 percent from the existing 15 percent, by 2010. The provisioning of higher public health investments will also be contingent upon the increase in absorptive capacity of the public health administration so as to gainfully utilize the funds.

Equity

To meet the objective of reducing various types of inequities and imbalances—interregional; across the rural-urban divide; and between economic classes—the most cost-effective method would be to increase the sectoral outlay in the primary health sector. Such outlets give access to a vast number of individuals, and also facilitate preventive and early stage curative initiative, which are cost-effective. In recognition of this public health principle, NHP-2001 envisages an increased allocation of 55 percent of the total public health investment for the primary health sector; the secondary and tertiary health sectors being targeted for 35 percent and 10 percent respectively. NHP-2001 projects that the increased aggregate outlays for the primary health sector will be utilized for strengthening existing facilities and opening additional public health service outlets, consistent with the norms for such facilities.

Delivery of National Public Health Programs

NHP-2001, envisages a key role for the Central Government in designing national programs with the active participation of the State Governments. Also, the Policy ensures the provisioning of financial resources, in addition to technical support, monitoring and evaluation at the national level by the Center. However, to optimize the utilization of the public health infrastructure at the primary level, NHP-2001 envisages the gradual convergence of all health programs under a single field administration. Vertical programs for control of major

diseases like TB, Malaria and HIV/AIDS would need to be continued till moderate levels of prevalence are reached. The integration of the programs will bring about a desirable optimization of outcomes through a convergence of all public health inputs. The policy also envisages that program implementation be effected through autonomous bodies at State and district levels. State Health Departments' interventions may be limited to the overall monitoring of the achievement of program targets and other technical aspects. The relative distancing of the program implementation from the State Health Departments will give the project team greater operational flexibility. Also the presence of State Government officials, social activists, private health professionals and MLAs/MPs on the management boards of the autonomous bodies will facilitate well-informed decision-making.

The State of Public Health Infrastructure

As has been highlighted in the earlier part of the Policy, the decentralized public health service outlets have become practically dysfunctional over large parts of the country. On account of resource constraint, the supply of drugs by the State Governments is grossly inadequate. The patients at the decentralized level have little use for diagnostic services, which in any case would still require them to purchase therapeutic drugs privately. In a situation in which the patient is not getting any therapeutic drugs, there is little incentive for the potential beneficiaries to seek the advice of the medical professionals in the public health system. This results in there being no demand for medical services, and medical professionals, and paramedics often absent themselves from their place of duty. It is also observed that the functioning of the public health service outlets in the four Southern States—Kerala, Andhra Pradesh, Tamil Nadu and Karnataka are relatively better, because some quantum of drugs is distributed through the primary health system network, and the patients have a stake in approaching the public health facilities. In this backdrop, NHP-2001 envisages the kick-starting of the revival of the Primary Health System by providing some essential drugs under Central Government funding through the decentralized health system. It is expected that the provisioning of essential drugs at the public health service centers will create a demand for other professional services from the local population, which, in turn, will boost the general revival of activities in these service centers. In sum, this initiative under NHP-2001 is launched in the belief that the creation of a beneficiary interest in the public health system, will ensure a more effective supervision of the public health personnel, through community monitoring, than has been achieved through the regular administrative line of control.

TABLE 26.14: Public health spending in selected countries

Indicator public	Percent population with income of < \$ 1 day	Infant mortality rate/1000	Percent health expenditure to GDP	Percent expenditure on health to total health
India	44.2	70	5.2	17.3
China	18.5	31	2.7	24.9
Sri Lanka	6.6	16	3	45.4
UK	—	6	5.8	96.9
USA	—	7	13.7	44.1

Global experience has shown that the quality of public health services, as reflected in the attainment of improved public health indices, is closely linked to the quantum and quality of investment through public funding in the primary health sector. **Table 26.14** gives statistics which show clearly that the standards of health are more a function of accurate targeting of expenditure on the decentralized primary sector (as observed in China and Sri Lanka), than a function of the aggregate health expenditure.

Therefore, NHP-2001, while commuting additional aggregate financial resources, places strong reliance on the strengthening of the primary health structure, with which to attain improved public health outcomes on an equitable basis. Further it, also recognizes the practical need for levying reasonable user-charges for certain secondary and tertiary public health care services, for those who can afford to pay.

Extending Public Health Services

NHP-2001 envisages that, in the context of the availability and spread of allopathic graduates in their jurisdiction, State Governments would consider the need for expanding the pool of medical practitioners to include a cadre of licentiates of medical practice, as also practitioners of Indian Systems of Medicine and Homeopathy. Simple services/procedures can be provided by such practitioners even outside their disciplines, as part of the basic primary health services in under-served areas. Also, NHP-2001 envisages that the scope of use of paramedical manpower of allopathic disciplines, in a prescribed functional area adjunct to their current functions, would also be examined for meeting simple public health requirements. These extended areas of functioning of different categories of medical manpower can be permitted, after adequate training and subject to the monitoring of their performance through professional councils.

NHP-2001 also recognizes the need for States to simplify the recruitment procedures and rules for contract employment in order to provide trained medical manpower in under-served areas.

Role of Local Self-Government Institutions

NHP-2001 lays great emphasis upon the implementation of public health programs through local self-Government institutions. The structure of the national disease control programs will have specific components for implementation through such entities. The Policy urges all State Governments to consider decentralizing implementation of the programs to such institutions by 2005. In order to achieve this, financial incentives, over and above the resources allocated for disease control programs, will be provided by the Central Government.

Medical Education

In order to ameliorate the problems being faced on account of the uneven spread of medical colleges in various parts of the country, NHP-2001, envisages the setting up of a Medical Grants Commission for funding new Government Medical Colleges in different parts of the country. Also, the Medical Grants Commission is envisaged to fund the upgradation of the existing Government Medical Colleges of the country, so as to ensure an improved standard of medical education in the country.

To enable fresh graduates to effectively contribute to the providing of primary health services, NHP-2001 identifies a significant need to modify the existing curriculum. A need based, skill-oriented syllabus, with a more significant component of practical training, would make fresh doctors useful immediately after graduation.

The policy emphasises the need to expose medical students, through the undergraduate syllabus, to the emerging concerns for geriatric disorders, as also to the cutting edge disciplines of contemporary medical research. The policy also envisages that the creation of additional seats for postgraduate courses should reflect the need for more manpower in the deficient specialities.

Need for Specialists in 'Public Health' and 'Family Medicine'

In order to alleviate the acute shortage of medical personnel with specialization in 'public health' and 'family medicine' disciplines, NHP-2001 envisages the progressive implementation of mandatory norms to raise the proportion of postgraduate seats in these discipline in medical training institutions, to reach a stage wherein 1/4th of the seats are earmarked for these disciplines. It is envisaged that in the sanctioning of postgraduate seats in future, it shall be insisted upon that a certain reasonable number of seats be allocated to 'public health' and 'family medicine' disciplines. Since, the 'public, health' discipline has an interface with many other developmental sectors, specialization in Public health may be encouraged not only for medical doctors but also for nonmedical graduates from the allied fields of

public health engineering, microbiology and other natural sciences.

Urban Health

NHP-2001, envisages the setting up of an organized urban primary health care structure. Since the physical features of an urban setting are different from those in the rural areas, the policy envisages the adoption of appropriate population norms for the urban public health infrastructure. The structure conceived under NHP-2001 is a two-tiered one: the primary centre is seen as the first-tier, covering a population of one lakh, with a dispensary providing OPD facility and essential drugs to enable access to all the national health programs; and a second-tier of the urban health organization at the level of the Government General Hospital, where reference is made from the primary center. The Policy envisages that the funding for the urban primary health system will be jointly borne by the local semi-Government institutions and State and Central Governments.

The National Health Policy also envisages the establishment of fully-equipped 'hub-spoke' trauma care networks in large urban agglomerations to reduce accident mortality.

Mental Health

NHP-2001 envisages a network of decentralised mental health services for ameliorating the more common categories of disorders. The program outline for such a disease would envisage diagnosis of common disorders by general duty medical staff and prescription of common therapeutic drugs.

In regard to mental health institutions for indoor treatment of patients, the policy envisages the upgrading of the physical infrastructure of such institutions at Central Government expense so as to secure the human rights of this vulnerable segment of society.

Information, Education and Communication

NHP-2001 envisages an IEC policy, which maximizes the dissemination of information to those population groups, which cannot be effectively approached through the mass media only. The focus would therefore, be on interpersonal communication of information and reliance on folk and other traditional media. The IEC programme would set specific targets for the association of PRIs/NGOs/Trusts in such activities. The program will also have the component of an annual evaluation of the performance of the non-governmental agencies to monitor the impact of the programmes on the targeted groups. The Central/State government initiative will also focus on the development of modules for information dissemination in such population groups who normally,

do not benefit from the more common media forms.

NHP-2001 envisages priority to school health programs aiming at preventive health education, regular health checkups and promotion of health seeking behaviour among children. The school health programs can gainfully adopt specially designed modules in order to disseminate information relating to 'health' and 'family life.' This is expected to be the most cost-effective intervention as it improves the level of awareness, not only of the extended family but the future generation as well.

Medical Research

NHP-2001 envisages the increase in Government-funded medical research to a level of 1 percent of total health spending by 2005; and thereafter, up to 2 percent by 2010. Domestic medical research would be focused on new therapeutic drugs and vaccines for tropical diseases, such as TB and Malaria, as also the subtypes of HIV/AIDS prevalent in the country. Research programs taken up by the Government in these priority areas would be conducted in a mission mode. Emphasis would also be paid to time-bound applied research for developing operational applications. This would ensure cost-effective dissemination of existing/future therapeutic drugs/vaccines in the general population. Private entrepreneurship will be encouraged in the field of medical research for new molecules/vaccines.

Role of the Private Sector

NHP-2001 envisages the enactment of suitable legislations for regulating minimum infrastructure and quality standards by 2003, in clinical establishments/medical institutions; also, statutory guidelines for the conduct of clinical practice and delivery of medical services are to be developed over the same period. The policy also encourages the setting up of private insurance instruments for increasing the scope of the coverage of the secondary and tertiary sector under private health insurance packages.

To capitalize on the comparative cost advantage enjoyed by domestic health facilities in the secondary and tertiary sector, the policy will encourage the supply of services to patients of foreign origin on payment. The tendering of such services on payment in foreign exchange will be treated as 'deemed exports' and will be made eligible for all fiscal incentives extended to export earnings.

NHP-2001 envisages the cooption of the non-governmental practitioners in the national disease control programmes so as to ensure that standard treatment protocols are followed in their day-to-day practice.

NHP-2001 recognizes the immense potential of use of information technology applications in the area of telemedicine in the tertiary health care sector. The use of this technical aid will greatly enhance the capacity for the professional's to pool their clinical experience.

Role of the Civil Society

NHP-2001 recognizes the significant contribution made by NGOs and other institutions of the civil society in making available health services to the community. In order to utilize on an increasing scale, their high motivational skills, NHP-2001 envisages that the disease control programs should earmark a definite portion of the budget in respect of identified program components, to be exclusively implemented through these institutions.

National Disease Surveillance Network

NHP-2001 envisages the full operationalization of an integrated disease control network from the lowest rung of public health administration to the Central Government, by 2005. The program for setting up this network will include components relating to installation of database handling hardware; IT interconnectivity between different tiers of the network; and, in-house training for data collection and interpretation for undertaking timely and effective response.

Health Statistics

NHP-2001 envisages the completion of baseline estimates for the incidence of the common diseases - TB, Malaria, Blindness—by 2005. The policy proposes that statistical methods be put in place to enable the periodic updating of these baseline estimates through representative sampling, under an appropriate statistical methodology. The policy also recognizes the need to establish in a longer time frame, baseline estimates for the noncommunicable diseases, like CVD, Cancer, Diabetes; accidental injuries; and other communicable diseases, like Hepatitis and JE. NHP-2001 envisages that, with access to such reliable data on the incidence of various diseases, the public health system would move closer to the objective of evidence-based policy making.

In an attempt at consolidating the database and graduating from a mere estimation of annual health expenditure. NHP-2001 emphasis on the needs to establish national health accounts, conforming to the 'source-to-users' matrix structure. Improved and comprehensive information through national health

accounts and accounting systems would pave the way for decision makers to focus on relative priorities, keeping in view the limited financial resources in the health sector.

Women's Health

NHP-2001 envisages the identification of specific programmes targeted at women's health. The policy notes that women, along with other under privileged groups are significantly handicapped due to a disproportionately low access to health care. The various policy recommendations of NHP-2001, in regard to the expansion of primary health sector infrastructure, will facilitate the increased access of women to basic health care. NHP-2001 commits the highest priority of the Central Government to the funding of the identified programmes relating to woman's health. Also, the policy recognizes the need to review the staffing norms of the public health administration to more comprehensively meet the specific requirements of women.

Medical Ethics

NHP-2001 envisages that, in order to ensure that the common patient is not subjected to irrational or profit-driven medical regimens, a contemporary code of ethics be notified and rigorously implemented by the Medical Council of India.

NHP-2001 does not offer any policy prescription at this stage relating to ethics in the conduct of medical research. By and large medical research within the country is limited in these frontier disciplines of gene manipulation and stem cell research. However, the policy recognises that a vigilant watch will have to be kept so that appropriate guidelines and statutory provisions are put in place when medical research in the country reaches the stage to make such issues relevant.

Enforcement of Quality Standards for Food and Drugs

NHP-2001 envisages that the food and drug administration will be progressively strengthened, both in terms of laboratory facilities and technical expertise. Also, the policy envisages that the standards of food items will be progressively tightened at a pace which will permit domestic food handling/manufacturing facilities to undertake the necessary upgradation of technology so as not to be shut out of this production sector. The policy envisages that, ultimately food standards will be close, if not equivalent, to codex specifications; and drug standards will be at par with the most rigorous ones adopted elsewhere.

Regulation of Standards in Paramedical Disciplines

NHP-2001 recognizes the need for the establishment of statutory professional councils for paramedical disciplines to register practitioners, maintain standards of training, as well as to monitor their performance.

Occupational Health

NHP-2001 envisages the periodic screening of the health conditions of the workers, particularly for high risk health disorders associated with their occupation.

Providing Medical Facilities to Users from Overseas

NHP-2001 strongly encourages the providing of health services on a commercial basis to service seekers from overseas. The providers of such services to patients from overseas will be encouraged by extending to their earnings in foreign exchange, all fiscal incentives available to other exporters of goods and services.

Impact of Globalization on the Health Sector

NHP-2001 takes into account the serious apprehension expressed by several health experts, of the possible threat to the health security, in the post-TRIPS era, as a result of a sharp increase in the prices of drugs and vaccines. To protect the citizens of the country from such a threat, NHP-2001 envisages a national patent regime for the future which, while being consistent with TRIPS, avails of all opportunities to secure for the country, under its patent laws, affordable access to the latest medical and other therapeutic discoveries. The policy also sets out that the Government will bring to bear its full influence in all international fora—UN, WHO, WTO, etc. to secure commitments on the part of the Nations of the globe to lighten the restrictive features of TRIPS in its application to the health care sector.

SUMMATION

The crafting of a National Health Policy is a rare occasion in public affairs when it would be legitimate, indeed valuable, to allow our dreams to mingle with our understanding of ground realities. Based purely on the clinical facts defining the current status of the health sector, we would have arrived at a certain policy formulation; but, buoyed by our dreams, we have ventured slightly beyond that in the shape of NHP-2001 which, in fact, defines a vision for the future.

The health needs of the country are enormous and the financial resources and managerial capacity available to meet it, even on the most optimistic projections, fall somewhat short. In this situation, NHP-2001 has had to make hard choices between various priorities and operational options. NHP-2001 does not claim to be a road-map for meeting all the health needs of the

populace of the country. Further, it has to be recognized that such health needs are also dynamic as threats in the area of public health keep changing over time. The policy, while being holistic, undertakes the necessary risk of recommending differing emphasis on different policy components. Broadly speaking, NHP-2001 focuses on the need for enhanced funding and an organizational restructuring of the national public health initiatives in order to facilitate more equitable access to the health facilities. Also, the policy is focused on those diseases which are principally contributing to the disease burden—TB, Malaria and Blindness from the category of historical diseases; and HIV/AIDS from the category of ‘newly emerging diseases.’ This is not to say that other items contributing to the disease burden of the country will be ignored; but only that, resources as also the principal focus of the public health administration, will recognize certain relative priorities.

One nagging imperative, which has influenced every aspect of NHP-2001, is the need to ensure that ‘equity’ in the health sector stands as an independent goal. In any future evaluation of its success or failure, NHP 2001, would like to be measured against this equity norm, rather than any other aggregated financial norm for the health sector. Consistent with the primacy given to ‘equity’ a marked emphasis has been provided in the policy for expanding and improving the primary health facilities, including the new concept of provisioning of essential drugs through Central funding. The policy also commits the Central Government to increased underwriting of the resources for meeting the minimum health needs of the citizenry. Thus, the policy attempts to provide guidance for prioritizing expenditure, thereby, facilitating rational resources allocation.

NHP-2001 highlights the expected roles of different participating groups in the health sector. Further, it recognizes the fact that, despite all that may be guaranteed by the Central Government for assisting public health programs, public health services would actually need to be delivered by the state administration, NGOs and other institutions of civil society. The attainment of improved health indices would be significantly dependent on population stabilization, as also on complementary efforts from other areas of the social sectors—like improved drinking water supply, basic sanitation, minimum nutrition, etc. to ensure that the exposure of the populace to health risks is minimized.

Health and Development

People often regard health as an investment without return, as a mere service doled out to the people. Perhaps it is this feeling in the mind of our planners which is responsible for the very low importance given to health in India’s budget (**Table 26.8**). It is essential to keep in mind that health is not only an outcome of

socioeconomic development but is also a determinant of the latter. In other words, health itself promotes development. To quote the UN Director General for Development and International Economic Cooperation, “The promotion and protection of the health of the people is essential to sustained economic and social development and contributes to a better quality of life and to world peace.”³¹ One possible reason why economic planners do not seem to be convinced about the beneficial effects of health upon development is the real difficulty in expressing the outcome of health programs in monetary terms. For example, how is one to assess the value of a life saved or a disease cured? However, whenever such analysis has been attempted, it has usually been found that investment in health can be defended on economic grounds.^{32,33} For example, it has been calculated that the annual loss due to childhood diarrhea amounted to as much as one-fourth of the annual budget for health during the sixth plan.³²

The economics of health is a newer term than medical economics: it encompasses the medical care industry and extends into such fields as the analysis of the economic costs of disease, benefits of control programs and returns from investment in education and training, etc. Many workers have tried to evaluate man or, in other words, to put a price upon his economic worth. It is generally agreed that the period of infancy and early childhood represents a drain upon family and community resources. In case of death, this investment made towards a productive age is, therefore, a loss to the community not only in terms of the investment made but also in terms of the loss of future earnings of the individual.²

Let us analyze the reciprocal relationship between health services and socioeconomic development.

How Health Promotes Development?

Increase in productivity: Disease and weakness compromise the working capacity of an individual, thus lowering his economic productivity. This is true at the level not only of the individual but also of the community, the industry and the nation as a whole. *At the individual level*, illness means loss of wage earning coupled with the expenditure incurred on treatment. *At the level of the community*, ill health operates by lowering the general capability and quality of leadership.² This would, in turn, tell upon the participatory group efforts of the community towards development. *At the level of the industry*, one obvious advantage of health inputs is the decreased absenteeism due to sickness. Another well established advantage is the increase in working capacity of workers. For example, studies in Kenya showed that food supplementation increased road workers, productivity by 13 percent.³⁴ A study in Indonesia showed that administration of iron supplements to workers over a

2-month period increased their productivity by 15 to 25 percent, the benefit-cost ratio being about 260.³⁵

Country Level Studies have been done in case of ascariasis, diarrhea, malaria and tuberculosis. According to a World Bank study,³⁶ Kenya incurs an annual loss equivalent to 5 million US dollars as a result of ascariasis infection. The benefit-cost ratio of a six monthly mass deworming program was estimated to be as high as 10 : 1. The annual loss due to childhood diarrhea in India has been estimated to be Rs. 88.6 crore.³² Sinton³⁷ calculated in 1936 that malaria caused a loss of Rs. 1000 crore per annum in India. According to him, “It constitutes one of the most important causes of economic misfortune engendering poverty, diminishing the quantity and quality of food supply, lowering the physical and intellectual standards of the nation and hampering increased prosperity and economic progress in every way.”

It is axiomatic that work capacity of an individual is related to his physical and psychomotor development. In this background, the Narangwal study in Punjab revealed interesting data. It was found that nutritional supplementation resulted in increase in height and psychomotor scores of children, the cost per cm gain in height and per percentage point gain in psychomotor score being \$ 26.25-30.40 and \$ 5.05-13.60 respectively.³⁸

National productivity also increases when health programs throw open hitherto unavailable avenues of production. A classical example is the large scale successful cultivation in the foothills of Himalayas (Himalayan Tarai) which became possible only after the dread of the highly rampant malaria was mitigated as a result of the National Malaria Program and the area became habitable. The same was experienced at a smaller scale in Pehowa Block of Haryana.² The victory of American troops in the second world war was attributable in a large measure to the successful use by US Army of DDT for control of malaria. It may be mentioned that DDT was developed for and available only to the army; it was provided for civilian use only after the war.

Decrease in loss due to mortality and morbidity:

These losses are of three types: cost of death, i.e. the value of each life saved; cost of morbidity, i.e. loss of work days and work efficiency due to sickness; and cost of treatment, i.e. money spent upon purchase of drugs, medical services, transport to hospital, etc. Such costing has been attempted in case of tuberculosis. It is estimated that the annual cost of mortality, morbidity and medical treatment due to tuberculosis in India are Rs. 420.4 crore, Rs. 288.6 crore and Rs. 29.7 crore respectively.³⁹ It should be noted that the expenditure on the national tuberculosis control program itself is comparatively small, i.e. Rs. 0.49 per person per annum. It is thus obvious that the investment in tuberculosis control is, in fact economically gainful.²

The cost of mortality, i.e. the equivalent economic gain for a life saved, is not easy to calculate. The value of an adult who is capable of earning is much more than that of a child. But even in case of a child, the value has been estimated to be Rs. 1900.³³ As against this, the cost of saving a young child's life through nutritional intervention has been estimated in the Narangwal project to vary from 7.75 to 101.45 US dollars, depending upon the age of the child and the type of intervention.³⁸ This indicates that the expenditure on saving a child's life through health and nutrition care has a benefit-cost ratio of 2 to 25.

Increased employment: Unemployment and under-employment are economic as well as social evils. Employment opportunities are decreased by physical or mental impairment, which may be caused, for example, by protein-energy malnutrition, anemia, preventable blindness, iodine deficiency (cretinism, deaf mutism), poliomyelitis, leprosy, tuberculosis, etc. All these conditions can be prevented or treated with a high benefit-cost ratio. Employment opportunities are directly related to performance at school. Studies in Nepal, China, Brazil and Columbia have revealed that school enrolment and performance was directly related to nutritional status of children.⁴⁰ Studies in 4 Latin American countries showed that illness caused children to be absent from school 50 days a year, the comparable number in US being only 8 days.⁴¹

Demographic effects: Health, nutrition and family welfare services result in decrease in birth rate, crude death rate, incidence of LBW babies, infant mortality rate, 1-4 years mortality rate and maternal mortality rate. The net result of these is increase in lifespan and a change in the population structure, characterized by decrease in the proportion of children and increase in the number of productive adults. This, in turn, increases national productivity and thus brings about economic development.

Better quality of life: The four factors discussed so far have mainly dealt with the economic aspects. But the social component of socioeconomic development is no less important. The complex social effects of health services may be summarized by saying that they improve the quality of life. Two of the three determinants of the *Physical Quality of Life Index (PQLI)*, relate to health, viz. infant mortality rate and longevity of life, the third being the literacy rate. However, quality of life also depends upon the degree of happiness and security enjoyed by the people. It is undisputed that adequate health services and good health are associated with a state of enthusiasm, vigor and happiness. This is expressed as follows by the Prime Minister of Thailand. "Any society should consider that a high quality of life, and I dare say happiness of the people, which can only be obtained through a sufficient level of health, is not only a basic prerequisite to

development but should be the basic objective of any development effort."⁴²

How Development Affects Health?

Health and health services cannot be but desirable, hence the question of their having adverse effects upon development does not arise. On the other hand, unlike optimum health, beyond which health cannot increase, there is nothing like a state of optimum economic development. Hence all types of economic development and the means to attain the same are not necessarily desirable in all circumstances. That is why socioeconomic development may have positive as well as negative effect upon health. This will be clear from the examples given below.

Effect upon health services: Economic development brings about quantitative and qualitative improvement in health services and thereby improves the health of people.

Demographic effects: It has been said that development is the best contraceptive and brings about a decrease in fertility. This, in turn, is associated with decrease in infant mortality,⁴³ a positive health effect.

Effects of unsustainable development:⁴⁴ Sustainable development is defined as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."⁴⁰ Unsustainable development, thus, means excessive economic development through injudicious exploitation of natural environment. The three main causes of environmental degradation are:

1. Mass poverty of the very poor
2. Wasteful consumption patterns of the very affluent
3. Short-term, rather than long-term, perspective of development efforts.⁴⁴

It should be noted here that too much poverty, as well as too much affluence, lead to environmental degradation and damage to earth's ecology. It is hence urgently desirable that rich nations, in the interest of their own survival, should help the poor countries to develop economically. Environmental degradation ultimately results in ill-health, due to either malnutrition or disease. The mechanisms involved are shown in **Figure 26.1**. An example of unsustainable development relates to agriculture sector. During last 1 to 2 decades, rice cultivation has markedly increased in Punjab. This has been made possible by intensive use of groundwater obtained from tube wells. As a result, groundwater level has dropped by 7 to 10 meters during last 20 years in parts of Punjab where paddy is cultivated. Similarly, a very large portion of available water in Maharashtra is cornered by the sugar barons and is used to cultivate sugarcane fields, a cash crop. In both these situations, where groundwater is used in huge quantities for paddy and sugarcane cultivation, this precious resource is depleted and the already low availability of drinking water is adversely affected.

HOW DEVELOPMENT MAY LEAD TO ILL-HEALTH THROUGH ENVIRONMENTAL DEGRADATION?

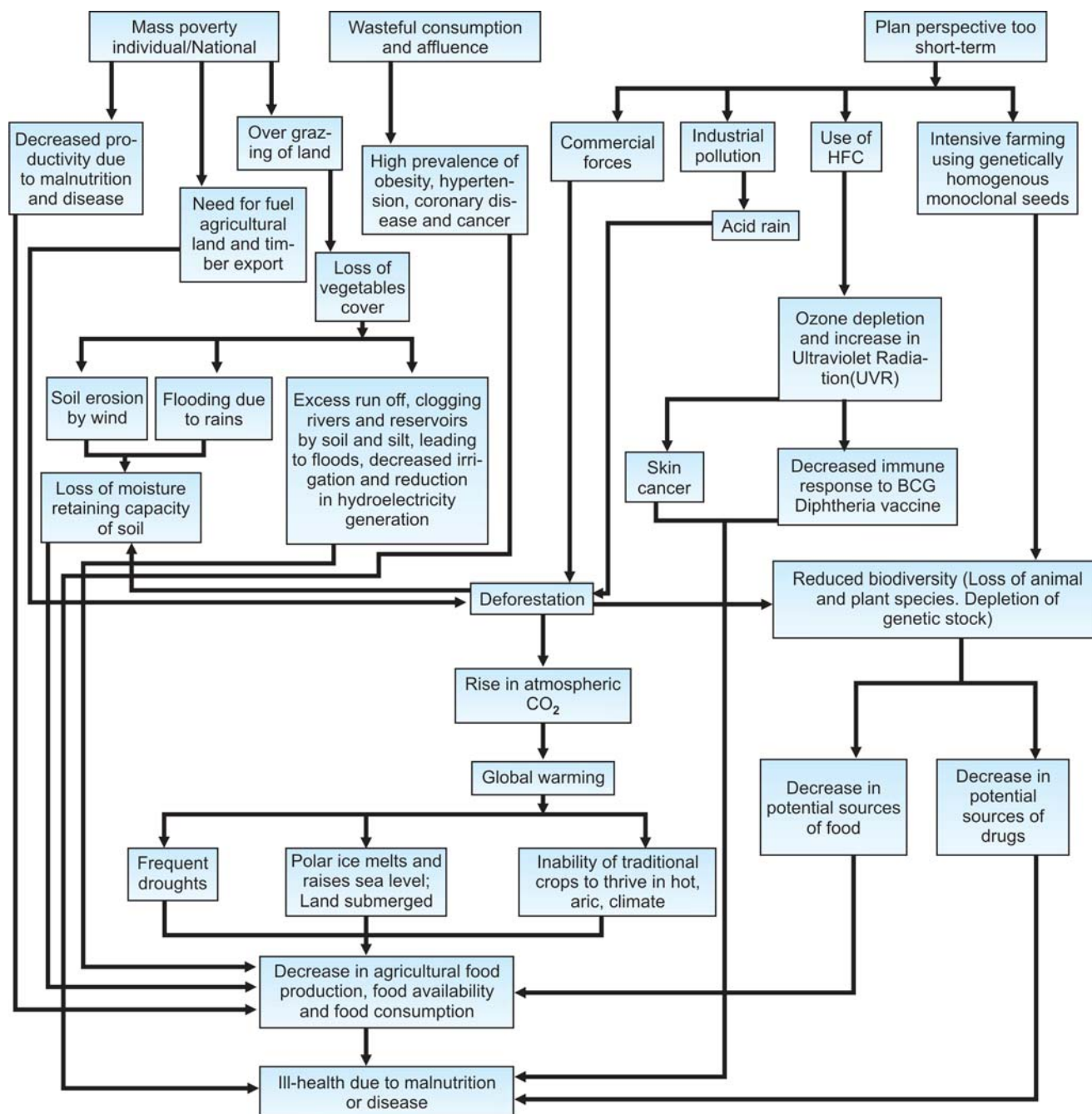


Fig. 26.1: Analytical model showing how improper or excessive pace of development can have harmful consequences for health through environmental degradation. Three main causes of environmental degradation are identified: Poverty, affluence and short-term policy perspectives. It may be noted that mass poverty forces people to adopt means of economic “development” that result in environmental degradation and are ultimately counter-productive.

HFC: Hydrofluorocarbons

Prepared on the basis of data in Ref. No. 44

Two projects currently under cloud because of their potential harmful effects upon environment are the Sardar Sarovar Project on river Narmada and the Tehri Dam Project in Garhwal.

High consumption is the basic cause leading to depletion of natural environment. The pattern of consumption in different countries is given in

Table 26.15. Comparing the *per capita consumption ratio in USA and India* (given in parentheses), the following comments may be made:

TABLE 26.15: Per capita consumption pattern in different countries^{16a}

Name of country	GNP per capita (1986, US \$)	Fat g	Daily protein g	Energy Kcal	Sugar kg	Annual commercial energy as oil, kg	Crude steel, kg	Newsprint kg
India	290	36	54	2126	11.2	208	17	0.5
Bangladesh	160	19	41	1804	2.4	46	4	0.4
China	300	41	62	2620	5.2	532	55	0.7
Japan	12840	85	88	2695	23.0	3186	569	23.5
Pakistan	350	53	59	2180	13.9	205	7	0.4
Sri Lanka	400	51	48	2485	16.8	139	5	1.1
USA	17480	164	107	3682	32.7	7193	479	51.8
USSR	4550	102	106	3332	48.0	4949	NA	4.3

FAT (RATIO 4.56)

US consumption too high, constituting about 40 percent of total calories intake. Needs to be halved.

SUGAR (RATIO 2.92)

US consumption too high, constituting about 40 percent of total calorie intake. High consumption is associated with caries.

ENERGY (RATIO 34.58)

High oil burning in US causes excessive air pollution.

NEWSPRINT (RATIO 103.6)

The high consumption of newsprint simply means high degradation of forests, and must be reduced.

A good example of harmful effects of economic and industrial development is the chlorofluorocarbons (CFC). These were synthesized in 1930 by Thomas Midgley in USA and were hailed as a wonder invention. These are noncorrosive, nontoxic, noninflammable, colorless, odorless compounds with a low boiling point, making them suitable for use as refrigerants and as constituents of cosmetics, such as shaving creams. Today, sixty years after their discovery, they stand discredited as a major threat to the survival of mankind because of the ecological damage caused by them. This damage occurs in two ways: (i) CFCs have a tendency to drift high into the atmosphere. There they are broken down by sunlight and chlorine atoms are released. These chlorine atoms convert ozone into oxygen. As a result the ozone layer around the earth gets depleted. Ozone serves the important purpose of filtering out excess ultraviolet radiation which is responsible for skin cancer and cataract. An ozone hole was discovered for the first time in 1947 and such findings have been repeatedly reported since then. (ii) CFCs, along with other "legacies" of the industrial revolution, such as carbon dioxide and sulphur dioxide, are capable of

causing global warming, the consequences of which are often catastrophic.

It is in view of the disastrous effects of the CFCs that it has been decided by international agreement to substitute CFCs by safer refrigerants such as hydrochlorofluorocarbons and hydrofluorocarbons.

Current Trends in Development

According to a recent decision of the development committee of the World Bank and IMF, the development priorities for the nineties have been fixed to be (i) Reduction of poverty, (ii) Sustainable growth (i.e., avoiding environmental damage) and (iii) Human resources development through greater attention to education and health.

Physical Quality of Life Index

Physical Quality of Life Index (PQLI) measures the *quality of life* or well-being of a country. PQLI encompasses three indicators like literacy rate, infant mortality and life expectancy at age one, giving equal weightage to all of them. PQLI value ranges from 0 to 100.

Human Development Index

Human Development Index (HDI) measures well-being, especially the child welfare, and was developed by Indian economist Amartya Sen and Pakistani economist Mahbub ul Haq in the year 1990. HDI combines three dimensions like life expectancy, literacy, education and standards of living for countries worldwide. Population health and longevity is expressed by life expectancy at birth, Knowledge and education is measured by the adult literacy rate (with two-thirds weighting) and the combined primary, secondary, and tertiary gross enrolment ratio (with one-third weighting), and standard of living, as indicated by the natural logarithm of gross domestic product per capita at purchasing power parity.⁴⁵

HDI value ranges from 0 to 1. According to HDI value, countries fall into four categories, e.g. very high (HDI value 0.900-1.000), high (0.800-0.899), medium (0.500-0.799) and low (0.000-0.499). The first category is referred to as developed countries and the last three are all grouped in developing countries. Previously, gross national income (GNI) in purchasing power parity (PPP) per capita, was included in calculating HDI, but now it has been replaced by gross domestic product (GDP) in purchasing power parity per capita. India's rank is 134 and belongs to medium HDI category with a score of 0.612.⁴⁶

Human Poverty Index

If human development is about enlarging choices, poverty means that opportunities and choices most basic to human development are denied: to lead a long, healthy, creative life and to enjoy a decent standard of living, freedom, dignity, self-respect and the respect of others. From a human development perspective, poverty means more than the lack of what is necessary for material well-being.

For policy-makers, the poverty of choices and opportunities is often more relevant than the poverty of income, for it focuses on the causes of poverty and leads directly to strategies of empowerment and other actions to enhance opportunities for everyone. Recognizing the poverty of choices and opportunities implies that poverty must be addressed in all its dimensions, not income alone.

The Human Development Report 1997 introduced a human poverty index (HPI) in an attempt to bring together in a composite index the different features of deprivation in the quality of life to arrive at an aggregate judgment on the extent of poverty in a community.

THE THREE INDICATORS OF THE HUMAN POVERTY INDEX (HPI)

Rather than measure poverty by income, the HPI uses indicators of the most basic dimensions of deprivation: a short life, lack of basic education and lack of access to public and private resources. The HPI concentrates on the deprivation in the three essential elements of human life already reflected in the HDI: longevity, knowledge and a decent living standard.

The first deprivation relates to survival: The vulnerability to death at a relatively early age and is represented in the HPI by the percentage of people expected to die before age 40.

The second dimension relates to knowledge: It is being excluded from the world of reading and communication and is measured by the percentage of adults who are illiterate.

The third aspect relates to a decent standard of living, in particular, overall economic provisions. This is represented by a composite of three variables: the percentage

TABLE 26.16: Top five states of India according to GDI and GEM for 2006

Ranking	States	
	GDI	GEM
1	Chandigarh	Andhra Pradesh
2	Goa	Goa
3	Kerala	Haryana
4	Delhi	Kerala
5	Puducherry	Maharashtra

of people with access to health services and to safe water, and the percentage of malnourished children under five.

Gender Development Index (GDI) and Gender Empowerment Measure (GEM)

Gender Development Index is calculated by comparing the infant mortality, life expectancy at age one, literacy rates, average years of education and estimated income per capita for girls and boys. The higher the GDI, the greater the gender equality. India's GDI has improved from 0.568 in 1996 to 0.633 in 2006.

Gender Empowerment Measure is calculated by measuring political and economic participation and control wielded by women in different Indian States. Like GDI, higher GEM represents greater empowerment of women. Political participation is calculated by taking into consideration the number of women legislators – at the center, assembly and the Panchayati Raj Institutions (PRI), the number of women candidates fielded by parties and the percentage of women voters in election. Economic participation has been calculated by evaluating the share of jobs held by women in the civil services of professionals graduating from medical; and engineering colleges and judges of high courts and the Supreme Court.

India has improved gender equality and empowerment by over 10 percent each over the past decade, but traditional laggard states remain virtually stagnant, the Center's first ever official quantitative rating of gender development has revealed. Kerala has lost its tag as the country's most gender equal state to Chandigarh, while women in Andhra Pradesh are the most empowered. Bihar is at the bottom of both GDI and GEM indices for both 1996 and 2006 (**Table 26.16**).

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Most countries, especially the developing ones, are concerned about the resources of health sector. Such concern broadly relates to: (i) The sources of finance for health services; (ii) The ability to maintain at least the past funding levels; (iii) Resource allocation patterns and, (iv) Economic efficiency, with equity, of health service delivery, etc.¹ In developed countries, too, with rich economies, the concern about the high costs of health care in the perspective of scarce resources, has called for close economic scrutiny and analysis of the health systems prevailing there. Economic concern about the rising cost of health services formed an important part of the political agenda during the presidential campaign of Bill Clinton in USA. In this background, it is important for all public health specialists, specially the health administrators, to know and apply the principles of economics in the field of health.

Concepts of health care financing and medical audit are important even for the clinicians. Refresher courses for clinicians have been recommended for orienting them towards the importance of using low cost remedies in place of costly substitutes.² This is particularly important in relation to health planning, management and health care delivery. The WHO organized in 1973, a seminar on health economics in which 18 countries from various regions participated. It is interesting to note that the following questions, to which clearer answers were sought at that seminar, are relevant even today: (i) What is a reasonable price to pay for health?; (ii) What are the relations between consumers and health services?; (iii) Do consumers of health services receive value for money? and, (iv) To what extent do consumers and/or products benefit from health services?

Basic Concepts

Before discussing the topic of health economics, it is appropriate to understand certain basic concepts and definitions related to economics.

Economics

It has been variously described as the study of wealth, study of welfare and study of scarcity. The related definitions are as follows:

STUDY OF WEALTH

Adam Smith, the father of economics, defined economics as a science which studies the nature and causes of national wealth. As a matter of fact, he wrote the book in 1776, commonly known as the *Wealth of Nations*, is titled “An Enquiry into the Nature and Causes of the Wealth of Nations.”

STUDY OF WELFARE

Marshall considered economics as a means or an instrument to better the conditions of life. He defined economics as “a study of mankind in the ordinary business of life; it examines that part of the individual and social action which is most closely connected with the attainment and use of the material requisites of well-being.”

STUDY OF SCARCITY

Robbins, who propounded economics as the study of scarcity, defines it as “the science which studies human behavior as a relationship between ends and scarce means which have alternative uses.”

Health Economics

Health economics has been explained by various authors in different ways. A general survey of some of the definitions suggests that health economics is the discipline that determines the price and the quantity of limited financial and nonfinancial resources devoted to the care of the sick and promotion of health.³ It covers the medical industry as a whole and extends to such fields as the economic analysis of the cost of diseases, benefits of health programs and returns from investment in medical education, training and research. The aim of economics applied to health field, or “health economics”, is to quantify overtime the resources used in health service delivery and to organize, allocate and manage them in such a way that they are used for health purposes with maximum efficiency in preventive, curative and rehabilitative health services, so as to achieve maximal individual and national productivity.

Against a background of increasing demands on limited health resources, economic evaluation helps decision making by considering the “outputs” of competing interventions in relation to the resources they consume.

There are four main types of economic analysis in health:

1. *Cost-minimization*: Here only inputs are compared and outputs are considered to be equal, which is rarely so.
2. *Cost-benefit*: In this type of analysis all outputs are measured in monetary terms.
3. *Cost-effectiveness*: Here a clinical output such as morbidity, mortality, reduction in blood pressure or quality of life, etc. is measured as a measure of the effectiveness. Cost-effectiveness analysis has generally superseded cost benefit analysis because of the problems of allocating monetary values to all outputs.
4. *Cost utility*: This measure allocates a quality of life value [between 1 (perfect health) and 0 (death) and combines quantity and quality of life to derive the Quality Adjusted Life Years {QALY}]. Although the cost utility method has the advantage that different interventions can be compared across a broad range of choices in resource allocation, a number of methodological problems remain.⁴

Scarcity

Scarcity exists in all walks of life. No one can buy or be provided with everything for indefinite time. In this context the economist’s notion of scarcity is of special interest. The health needs (whether perceived from the angle of the professional providers or from the point of view of community needs) are *infinite* whereas the resources are definitely limited, in India as elsewhere. For this reason alone, welfare governments everywhere try to ensure that economic thinking is built more closely in the planning and decision making process, keeping the cardinal concept of scarcity in view.

Demand

It means, in simple terms, the type, quantity and quality of services or commodities wanted or requested. However, the demand for health and medical care, in strict economic sense, is a function of: (a) consumer’s income; (b) the price of medical care relative to the prices of other goods and, (c) tastes and preferences of consumers, including their perceptions about health and health care. Mere expressions of health needs and wants do not become demands, or effective demands, for health care services unless they are backed or supported by *willingness and ability to pay* for these needs and wants. The ability to pay and sacrifice for

securing health services could be viewed in monetary as well as nonmonetary terms. When services are provided by the government, these should not be considered, in strict economic sense, free or without cost. Thus even for availing of the so-called free services, one has to make sacrifice in terms of traveling and waiting time and transportation cost, etc.

GNP and GDP

Gross National Product (GNP) and Gross Domestic Product (GDP) are the conventional terms used to understand the performance of economy. These indicate the sum total of three components in a country, namely: (a) personal consumption; (b) expenditure on goods and services, and (c) investment expenditure. GNP and GDP serve as measures of total (gross) production of goods and services in a country during a year. Only final products, goods and services are added for this purpose. The only difference between GNP and GDP is property income received from or paid outside the country. Any net gain or loss on this account is added or subtracted from Gross Domestic Product to derive the Gross National Product (GNP).

It may be mentioned that the *National Income* differs from GNP. It consists of total income of all individuals in the country through means of salary, profits, interest, etc. after allowing for the depreciation of durable capital goods and items such as building, equipment, machinery, etc.

Poverty Line

Poverty line is generally defined in terms of minimum per capita consumption level of the people. As per the definition given by the planning commission, this level is the caloric intake of people. Thus poverty line refers to the cut off point of income below which people are not able to purchase food sufficient to provide 2400 kcal per head per day. This income level has been fixed by the planning commission at Rs. 119.50 per head in rural areas and Rs. 138 in urban areas at 1987-88 prices. Definitions and methodologies used for estimating poverty line differ from one source to other. According to the sixth five-year plan document, “A family having five members, whose annual income is less than Rs. 3500, is said to be living below poverty line.” This income limit was increased to Rs. 6400 in the seventh plan. It was further raised to Rs. 7200 as per the eighth plan document.

Cost

Costs can be classified in many ways. In general, costs refer to the resources which are spent in carrying out health activities so far as the health care sector is concerned. It is to be understood that “unrealized” or “non-

realized” benefits also count towards costs. An example could be the loss of productivity due to morbidity, disability or mortality.

In general, costs can be classified into two broad groups: capital costs and operating (sometimes known as recurrent) costs.

1. **Capital costs:** These costs are borne irrespective of the workload of any health center and are fixed. These may include:
 - Building, i.e. the health center, hospital, etc.
 - Major items of equipment. In order to compute the yearly costs of such items as building, refrigerator, etc. it is convenient to express these in terms of replacement costs assuming a certain expected life for capital items like building, etc. Capital costs are also termed as capital expenditure; capital goods represent capital investment.
2. **Operating costs:** These costs are related to the level or type of activity in a health institution. Some operating costs will change daily and some from year to year. These operating costs include:
 - Salaries, wages and allowances of health staff at different levels
 - Medical supplies, drugs, etc.
 - Transport operating costs
 - Maintenance and repairs
 - Training
 - Power
 - Other miscellaneous items.

Operating costs may also be seen as indirect or overhead costs related to the expenses associated with utilities, administration and supervision.

OTHER CONCEPTS RELATED TO COSTS

- **Marginal costs:** These refer to the amount, at any given volume of output, by which aggregate costs are changed if the volume of output is increased or decreased by one unit. These costs occur when one more unit is added. The concept of marginality is also applicable to benefits, value, income and production. However, in case of production of health care services, it reflects the changes in total cost at a given scale of output when a little more or little less output is produced.

The concept of *margin* is very important in health planning as we are seldom concerned with totally eliminating one activity and starting an altogether new one. Most of the decisions are taken in the margin, considering as to how much additional cost is involved in moderately expanding the output or how much cost-expenditure is saved by cutting the output a little.
- **Social cost:** It is the cost of a health activity to the society and not merely or solely to the agency, institution or sector carrying out the activity.

- **Unit cost:** It is also known as average cost. It is the total cost of an activity divided by the number of units of output produced.
- **Opportunity cost:** This economic concept is quite important and usually forgotten in costing. It is the value of the next best alternative forgone in order to achieve something. The economist’s notion about opportunity costs implies that the cost of providing one form of health care should always be balanced against the benefits which have to be sacrificed. So, one possible economic approach for the health manager is to consider:
 - What is the most valuable thing we are doing?
 - What is the most valuable thing we are not doing?
 - What shift of health resources is needed if the latter is greater than the former, i.e. B is greater than A. Opportunity costs operate not from the angle of the provider manager alone but also from the angle of the consumer or the beneficiary of health services. Nothing is free for the consumer even if it appears to be given free; the consumer has to incur some opportunity cost in terms of traveling time, transportation cost, loss of leave or wages, etc.
- **Cost accounting:** Cost accounting can be defined “as a process of manipulating or rearranging the data or information in the existing accounts in order to obtain the cost of services rendered by an organization”. Cost accounting will not improve efficiency by itself; it has to be combined with appropriate management techniques in an organization. Cost analysis provides a tool of measuring success in monetary terms and thus helps to control and monitor the costs.

Cost accounting assists health administrators in controlling the costs and monitoring the progress of various services. Thereby, it can lead to rational allocation of scarce health resources.⁵

Benefits

The benefits of a health program or project are the desired effects of the program. Conversely, the failure to use the available resources, technology, etc. in the best possible way, results in a loss to the project, the program, the institution and, ultimately, the community. This loss is expressed by the term opportunity cost mentioned above.

Cost Benefit Analysis (CBA)

It refers to a formalized way of comparing the advantages (benefits) and disadvantages (costs) of undertaking an activity, project or program. While computing the costs and benefits, appropriate use is

made of the principle of discounting whereby the worth of returns received early during the life of a project is considered more than that of later returns.

Cost benefit analysis, as an economic technique applicable to health planning, health management and evaluation, is the systematic comparison in financial or monetary terms of all the costs and benefits of the proposed alternative schemes with a view to determining: (a) which scheme or combination of schemes will contribute most to achievement at a fixed given investment or (b) the magnitude of benefits that can result from schemes requiring the minimum investment.

Cost benefit analysis involves measuring costs and benefits in commensurate monetary terms. Welfare economics shows that any net excess of monetary benefits over costs represents the gain in welfare by society. Cost benefit analysis makes it possible to determine, firstly, whether an individual intervention offers an overall net welfare gain and secondly, how the welfare gain from that intervention compares with that from alternative interventions. Increased use of interventions with the greatest net gain will increase efficiency. By valuing all costs and benefits in the same units, cost benefit analysis compares diverse interventions using the benefit criteria.⁶

Cost benefit analysis attempts to value all *socially relevant* outcomes in monetary terms. In day-to-day use, cost benefit analysis is primarily utilized to justify a particular health service program. Although it is difficult to express all possible health and social benefits in financial terms, CBA help in taking technical decisions backed by economic logic. The ultimate unit of measurement in this technique is money value to society.

Cost-effectiveness Analysis (CEA)

The principle of CEA is applicable even in day-to-day life when we are confronted with choices and outcomes. For example, we may have to decide, “Should we eat dinner at home or go to a restaurant?” or, “Should we drive to work by car, take bus, use cycle or go on foot?” Cost-effectiveness analysis is a formal planning and evaluation technique having both economic and technical components. It involves organizing information so that the costs of alternatives and their effectiveness in meeting a given objective can be compared systematically. CEA involves three distinct subprocesses: (a) Developing comprehensive cost stream data and analysis of cost of each alternative; (b) An analysis of effectiveness of each alternative; (c) An analysis of the relationship between the costs and effectiveness of each alternative.

Cost-effectiveness (CE) ratio is calculated by dividing cost of an alternative, expressed in monetary terms, by the effectiveness of that alternative, usually expressed in nonmonetary terms. CEA measures health benefits in natural units such as life years saved or improvements

in functional status (units of blood pressure or cholesterol, etc.). Since costs and benefits are measured in non-comparable units, their ratio provides a yardstick with which to measure productive efficiency. If an intervention is both more expensive and more effective than an alternative then the criterion for efficiency becomes the ratio of the net increase in costs to the net increase in effectiveness. However, the additional expense of the new intervention means that resources have to be redirected from elsewhere. CEA assesses whether or not the additional benefits generated by the new intervention are greater than the loss in benefits from the reduction in the other program. A major limitation of CEA is its inability to compare interventions with differing natural effects. For example interventions improving life years cannot be compared with interventions improving physical functioning.⁶ Cost benefit ratio is often confused with cost effectiveness ratio. It should be remembered that the denominator in CB ratio is expressed in monetary terms while that in CE ratio is in nonmonetary terms.

EXAMPLES OF CEA

- Let us assume to compare two alternative strategies for child survival. Strategy A is a preventive approach, say immunization. Strategy B is a curative approach, say treatment of tuberculosis. We want to use the fixed budget approach (**Table 27.1**). In this scenario, the CEA would take the following form:
It is clear that alternative A is more cost effective than ‘B’.
- Let us assume that there are 3 subalternatives to implement the strategy alternative A selected above. We wish to find which of the three subalternatives is most cost effective. We want to use the fixed target approach (**Table 27.2**). In this scenario, the CEA would be on the following lines:

TABLE 27.1: Comparison of two alternative strategies under the cost-effectiveness analysis

Alternative health program, strategy or activity	Resources or financial costs	Health impact or effectiveness in terms of lives saved	CE ratio
A	Rs. 25,000	100 lives saved	Rs. 250 per life
B	Rs. 25,000	15 lives saved	Rs. 1677 per life

TABLE 27.2: The approaches for an alternative strategy

Approaches for strategy ‘A’ which was found cost effective	Effectiveness	Cost (Rs.)	CE ratio
• Campaign	15,000	Rs. 75,000 immunizations	Rs. 5 per immunization
• MCH clinic	15,000	Rs. 45,000 immunizations	Rs. 3 per immunization
• Mobile clinic	15,000	Rs. 65,000 immunizations	Rs. 4.33 per immunization

A practical example is a recent study undertaken to compare the cost effectiveness of directly observed treatment (DOTS) in tuberculosis with the conventional treatment of tuberculosis. Cure rates were used as the measure of effectiveness in this study. All patient costs, community costs and treatment costs were calculated using standard procedure. Cost effectiveness was calculated in three ways. First, the proportion of patients who completed treatment was multiplied by the cost of managing a patient upto the completion of treatment. Secondly, the cost of patients not completing treatment was calculated by multiplying the patient management costs (assuming that default would occur at the time of discharge from hospital) by the proportion of patients not completing treatment. Thirdly, the cumulative costs of both types of patients were divided by the cure rate. It was concluded that DOTS was 2.7 times cheaper for the health system, 3 times cheaper for the patient and 2.8 times cheaper overall. DOTS was found to be 2.4 to 4.2 times more cost effective compared to conventional treatment. It was therefore concluded that DOTS should replace conventional treatment of tuberculosis.⁷

Cost Utility Analysis

This is an adaptation of CEA which measures an intervention's effect on both the qualitative and quantitative aspects of health (morbidity and mortality) using a utility based measure such as QALY. An intervention is deemed efficient, relative to an alternative if it results in higher (or equal) benefits at a lower cost. The use of a single measure of health benefit enables diverse health care interventions to be compared.⁶

In summary, it can be seen that the three types of evaluations use three different types of outcomes measurement:⁸

1. Cost effectiveness—clinical end points
2. Cost benefit—condition specific outcome measures
3. Cost utility—mortality; years of life.

Budget

In the context of health, *the budget is a systematic economic plan for a specific period of time*. It incorporates politically and technically determined appropriations indicating in what way and for what purpose various health resources are to be used. Budgeting refers to the process by which the budget comes into being. Budgeting is a means of ensuring that program decisions become budget decisions. The next stage after budgeting is control on budget or budgetary control. This involves designating the spending authority for delivering the health program and ensuring that the budget is spent judiciously for various aspects of the program. The latter is done through *program*

budgeting, which is defined as the process that links budgeting to programming. Health budgeting and program budgeting are essential components of the Managerial Process for National Health Development (MPNHD).

Allocations

In Health Economics the term 'allocations for health care' at a given point in time or over a period of time, refers to the distribution of resources, both in monetary and non-monetary sense, within a program. This general term covers such specialized expressions as apportioning or apportionment, allotment, etc.

Health Financing

There are several macro and micro aspects of economics relevant to the health sector. Out of these, the aspect of Financing of Health Care is particularly important. Health financing, in general, refers to raising of resources to pay for goods and services related to health. These resources may be in the form of "cash" or "kind". Financing of health care is viewed within the framework of scarcity of resources, their sustainability and their efficiency. A broad categorization of the sources of health care financing is as follows:

- Public sources (Government sources)
- Private sources (including nongovernment, corporate and private bodies)
- External cooperation or aid (bilateral or international)
- Individual or household
- Mixed sources.

Besides the above, another category of financing could be through health insurance, both compulsory and voluntary. Major problems in health financing are as follows:

- Lack of funds
- Unequal distribution of health finances
- Rising health costs
- Lack of coordination in health financing units
- Wastage and inefficiency in spending the funds or resources available.

Some Practical Considerations

Cost of Medical Care: Government System vs Privatization

Medical care is costly business. The American health industry is \$900 billion strong. Bill Clinton, President of the USA, described American health care as the "costliest and the most wasteful system on the face of the earth" and vowed, to revamp it as part of his election manifesto in 1993.⁸

Health care is highly privatised in USA. The result is that a one-fourth of population cannot afford the high cost of health care. In contrast, Canada, which had a health care system similar to USA earlier, introduced the National Health Service in 1971. The result is that its health expenditure, as percentage of GDP, has remained stable since then. It enjoys universal health coverage without user charges. The excellence of the National Health Service in UK is also well known.

The message for India is clear. Some checks must be applied in time to ensure that the costly mistakes of the West are not repeated here. We must not allow priorities to be distorted in the name of privatization. For example, while a Rs. 60 lakh CT scan machine can cater to 4000 patients a year, the same funds would serve 40,000 patients in a rural hospital. There is nothing wrong in encouraging private spending in health as a national policy. However, it would be far better to create conditions whereby the private entrepreneur finds it more attractive to set up a rural hospital than a CT scan diagnostic centre in a metropolitan city. This calls for hard sociopolitical decisions by the Government. It is the Government's responsibility to ensure that the scarce health resources are not wasted in irrational diagnostic tests and treatments even at the private level. As an example of the latter, the findings in a countrywide survey by the National Council of Applied Economic Research are revealing. It was found that 8 percent of the income of the poorest households is spent on injections, a supposed cure-all. Unfortunately, the three most cost effective injections—penicillin, streptomycin and immunization—are the least frequently prescribed.

To summarize, it is essential that all relatively wasteful expenditure, i.e. expenditure in less cost beneficial interventions, should be minimized. This applies to both private and government expenditure on health. The examples of less cost beneficial private expenditure have been given above. An example of lopsided priorities in governmental expenditure is provided by a case study of Rajasthan.² It was found that one-fifth of the total health budget in Rajasthan in 1990-91 was taken up by the five medical colleges and their attached teaching hospitals alone. This leaves relatively insufficient amount for primary health care of the population scattered in the rural areas.

DALY vs Health Care Costs

DALY stands for Disability Adjusted Life Year. This parameter has been used by World Bank as a measure that combines healthy life years lost because of premature mortality with those lost as result of disability.⁹ The total loss of DALYs is referred to as the *global burden of disease*. It is important to note that at global level, premature mortality contributes much more to DALY than disability. In the established market economies of the West, the total DALYs lost per 1000 population amount to 100, with about equal contribution by mortality and

disability. On the other hand, the number of DALYs lost per 1000 population in India is 350, the death and disability components being 250 and 100 respectively.⁹

In these days of global resource crunch, it stands to reason that a country should channelise its health care expenditure in such a manner as to achieve maximum reduction in DALYs lost at minimal cost. Using this yardstick, the World Bank has suggested a *minimum, package of public health and essential clinical services* for low and middle income countries as follows.⁹

PUBLIC HEALTH PACKAGE

- Immunizations
- School based health services
- Information and selected services for family planning and nutrition
- Programs to reduce tobacco and alcohol consumption
- Regulatory action, information, and limited public investments to improve the household environment
- AIDS prevention

Several of the above strategies are highly cost effective, varying from 25 to 150 US dollars per DALY saved.

ESSENTIAL CLINICAL SERVICES PACKAGE

- Services to ensure pregnancy-related (prenatal, childbirth, and postpartum) care
- Family planning services
- Tuberculosis control, mainly through drug therapy
- Control of STDs
- Care for the common serious illnesses of young children such as diarrheal disease, acute respiratory infection, measles, malaria, and acute malnutrition.

Each of the above five is highly cost effective, costing substantially less than \$ 50 per DALY gained.

World Bank calculations for developing countries reveal the following benefits by using the minimal package described above **Table 27.3:**⁹

Medical Quality and Audit

In the medical sector, there are three methods of rating quality, namely, structure quality, process quality and product quality.

TABLE 27.3: Health source component and their annual cost

Component	Annual cost per capita \$	Cost as percent of per capita income	Reduction in burden of disease percent
Public health	4.2	1.2	8
Essential clinical services	7.8	2.2	24
Total	12.0	3.4	32

The *structure quality* of a hospital can be seen in the provision of varying personnel density relative to the individual patient and the provision of equipment and procedures relative to the needs depending upon the nature of clinical areas catered to in the hospital.

The *process quality* of a hospital can be ascertained by examining the operating processes. This is done by verifying whether the existing resources in the personnel and material sector are rationally made use of for the benefit of the patients.

The *product quality or the quality of medical performance* is expressed primarily in terms of the results of medical treatment relative to the patient's state of health.

An assessment by doctors and other health care professionals as regards their own practices is widely regarded as a key activity. This activity, known as *medical audit* covers a variety of different approaches, all aimed at improving the standard of care. It is defined as an evaluation of the quality of medical care through the analysis of medical records. It is a very powerful regulatory mechanism which raises the quality of medical care being rendered to hospitalized patients through the review of the work of the medical staff by a committee comprising medical staff itself. In this way, hospital procedures and practices can be streamlined by identifying bottlenecks in hospital services. The broad objectives of a medical audit are: (a) improved quality of care; (b) a clear definition of responsibilities; (c) stimulation of research and development; (d) improved safety; and (e) providing a basis for assessing care. It helps to minimize professional and administrative practices which hinder the delivery of effective medical care. The proceedings of the medical audit committee should be kept confidential and only the concerned medical staff should be informed of the observations of the medical audit committee.

In India, the medical audit system has been introduced in some NGO hospitals and private hospitals, but not yet in most government hospitals. A recent medical audit study on management of diarrhea patients in a teaching hospital showed that 53 percent infants with diarrhea were treated with drugs alone, without ORS or advice about home available fluids.¹⁰

It may be mentioned that the efficiency of a health facility can be estimated as per the following four parameters:²

1. Structural efficiency
2. Operational efficiency
3. Cost-effectiveness
4. Social cost benefit analysis.

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World Health Day 2009: Make Hospitals Safe in Emergencies

The Constitution of India clearly recognizes the Government responsibility for health and states that “The State shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties.” The preamble to the WHO constitution states: “The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition” (Article 47). The 1948 UN Universal Declaration of Human Rights proclaims: “Everyone has right to a standard of living adequate for health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control. Motherhood and childhood are entitled to special care and assistance” (Article 25).

Imbalance in Health Care and its Causes

The present day health care system in India is unfairly weighted in favor of the urban rich, is mainly cure oriented and is not accessible to the vast rural population. This situation is the result of *three basic causes* as follows:¹

Lack of a Positive, Dynamic and Multidimensional Concept of Health

The WHO definition of health has two components. The first is a positive statement, affirming that “Health is a state of complete physical, mental and social well-being.” The second is a negative statement that “it is not merely an absence of disease and infirmity.” However, in practice, the majority of health professionals continue to concentrate only upon the second component with utter disregard for the far more important first

component. This has resulted in a situation when health is understood by the health professionals predominantly in biological, individualistic, clinical and curative terms. A holistic approach to health is essential to grasp the full relevance of community health care and to reduce the exaggerated importance usually given to medical professionals and costly drugs.¹ Such exaggerated importance is the result of neglect shown towards the Indian systems of Ayurveda and Yoga which are more concerned with maintenance of bodily and mental health than with mere cure of disease.² These systems are currently being advocated even in the affluent countries.

Social Injustice

Justice is a central issue in health care. According to the World Bank, “present health policies are not only inefficient but also inequitable in most developing countries.”³ A primarily hospital oriented health care system is not only ineffective and inefficient but also unjust since it does not lead to an equitable distribution of resources. In fact, there is an unjust and uneven distribution of health care.

Other Socioeconomic, Cultural, Religious and Political Factors

Health is not an independent system. It is a subsystem in society and basically reflects the socioeconomic, political and ideological systems. It has been said that “Health is not mainly an issue of doctors, medical services and hospitals. It is an issue of who gets what available resources. If poor health patterns are to be changed, then changes must be made in the entire socioeconomic political system in any given community.”⁴ In connection with the impact of politics upon health care, two points have been emphasized² (i) The initial national commitment to tackle public health problems, mainly communicable diseases, and to direct the national resources towards providing health benefits to the rural poor, has given place to a tendency towards providing expensive, urban hospital based, curative medicine for disease like cancer, heart disease, etc. for which little is achieved at much expense; (ii) There is an “involvement of politicians in the conversion

of medicine into a highly lucrative health industry in an area where consumer resistance is at its weakest.”² Examples cited therein are: (a) Establishment of capitation fee in medical colleges by politicians; (b) Excessive production of drugs; (c) Import of expensive medical equipment.

Health Problems in India

Before discussing the health care system, it is worthwhile to consider what are the major health problems in India. These are briefly reviewed here.

Population Problem

India's population was 1027 million in 2001. It is alarming to note that India's population is more than that of USA, USSR and Japan put together and that India adds to itself every year 18 million people, equivalent to the population of Australia, at the rate of 50,000 babies per day. Population explosion absorbs the national income and lowers the standard of living. It leads to food shortage since it often exceeds increase in food production. In a study by the FAO, one-third of the 72 developing countries were found to lag behind in food production in comparison to the growth of population.⁵ Uncontrolled fertility directly threatens the health of mothers and infants and may undermine the health of other family members as well. Some illustrative facts in this connection are as follows: (i) Infants born within 18 months of the birth of a previous child are 2 and 3 times more likely to die than those born after longer interval, as shown by studies in Kenya and Egypt respectively; (ii) Babies born in Indonesia to mothers aged less than 18 years are 50% more likely to die than those born to mothers aged 20-24 years; (iii) According to surveys in 25 developing countries in 1980's, 35% births occur within 24 months of previous births, though many women wish to avoid these. If these births could be delayed till women want them, then overall child mortality would decrease by 20% in all these countries taken together and by 30% in some countries of South America.

In addition to the above, rapid population growth has serious pollutional consequences as well. It has been labeled as the prime cause of pollution and environmental degradation in the world today. At a rate of increase of 2.1% every year, population doubles in just 30 years. But there is no associated doubling of resources. Increased demand for fuel and living space further accelerates the rate of deforestation. More deforestation, mining and construction work lead to higher dust pollution and floods. Production of more goods needed by more people means higher industrialization and industrial pollution. More transportation need for more people means higher vehicular pollution. Burning of more fuel for transport, cooking and electricity needed by more people means higher carbon dioxide production. The

net result is high environmental pollution as a result of high population growth. Coupled with this is the increasing amount of nonbiodegradable wastes which pollute the environment.

MALNUTRITION

Nutritional problems have been discussed in detail in Chapter 22. The major problems are protein-energy malnutrition, low birth weight, anemia, xerophthalmia and iodine deficiency disorders. The national health goals provided for reduction of LBW to 10% by 2000 AD and for reduction in incidence of goiter by that time to near zero.

Lack of Environmental Sanitation

This includes the twin problems of unhygienic methods of excreta disposal and nonavailability of safe drinking water. These together are responsible for the high incidence of diarrheal diseases, polio and infective hepatitis, etc. The national goal aimed at providing safe water and safe excreta disposal facilities for 100% population by 2000 AD.

High Prevalence of Communicable Diseases

These include malaria, filaria, leprosy, diarrheal diseases, UIP target diseases (including tuberculosis) and viral hepatitis, enteric fever, kala-azar, STD, etc. They account for a very high rate of morbidity and mortality. To take just one example, as many as 40% persons in the population are infected with tubercle bacilli (i.e. are tuberculin positive) and 1.5% have radiological evidence of pulmonary tuberculosis. Of the latter, about one-fourth are sputum positive. The number of pulmonary tuberculosis patients in India is estimated to be 9 to 10 million, of whom 2.5 million are open cases. Nearly 4 million people are now believed to be HIV positive.

Lack of Medical Care Facilities

This is evident from the fact that about 75% medical facilities are concentrated in urban areas where only about 25% population resides, resulting in gross unavailability of health care support in the rural areas.

Health Care

Levels of Health Care

Health care is customarily described as consisting of a three-tier pattern as follows:

1. **Primary health care:** This is the essential health care provided at the first level of contact of the individual or the family with the National Health System. It is provided at the level of the primary

health center and subcenter by the medical officer and the health worker (Male and Female) respectively. At the village level, it is provided by the village health guide and the trained *dai*. The anganwadi worker in the ICDS scheme also provides important health-related services at village level.

2. **Secondary health care:** This refers to an intermediate level of health care where specialist facilities are available to deal with the complex health problems referred from the primary level. The community health centers and the district hospitals represent the secondary health care level.
3. **Tertiary level:** This is the highest level where super specialities are available and sophisticated investigations and therapeutic procedures can be performed. Tertiary health care is available at medical college hospitals and at regional or All India Hospitals and Institutions.

Primary Health Care

In 1977, the World Health Assembly gave the call of 'Health for All by 2000 AD'. Health for All basically meant that individuals should attain a level of health which would enable them to earn their livelihood and lead a socially congenial life. If this level of health is achieved, the individual and family needs would be adequately met. The challenge, however, was how to ensure the level of health that would ensure a socially and economically productive life. In pursuance of the decision of the World Health Assembly and the executive board of UNICEF and at the invitation of the Government of the erstwhile USSR, an International Conference on Primary Health Care was organized at Alma Ata, the capital of Kazakhstan, from 6 to 12th September 1978. The conference emphasized that the key to attain the goal of Health for All by 2000 AD was through implementation of Primary Health Care.⁶ The recommendations of the conference are given in Appendix. A perusal of these appendices will be very helpful for a full understanding of the concept of Primary Health Care.

Primary Health Care has been defined as essential health care made universally accessible to individuals and acceptable to them, *through their full participation* and at a cost the community and country can afford. "It forms an integral part of the country's health system and of the overall social and economic development of the community. It is the first level of contact of the individual, the family and the community with the national health system, bringing health care as close as possible to where people live and work. It constitutes the first element of a continuing health care process.

A vital feature of primary health care is that it is based upon participation of the people themselves. The component of people's participation needs to be specially emphasized. Many health programs have failed

because they were perceived by the people not as their own programs but rather as those of the government. This is true not only of health programs but of other programs as well. Empowering the people by decentralizing decision making is a vital precondition for such programs to take off and sustain themselves.

Primary Health Care is equally valid for all countries, though the problems addressed at this level would differ between the developing and developed countries. Primary Health Care is concerned with the main health problems of the community, providing promotive, preventive, curative and rehabilitative services as required.

CHARACTERISTICS OF PRIMARY HEALTH CARE

- It is essential health care which is based on practical, scientifically sound and socially acceptable methods and technology.
- It should be rendered universally, acceptable to individuals and the families in the community through their full participation.
- Its availability should be at a cost which the community and country can afford to maintain at every stage of their development in a spirit of self-reliance and self-development.
- It requires joint efforts of the health sector and other health-related factors, viz., education, food and agriculture, social welfare, animal husbandry, housing, rural reconstruction, etc.

COMPONENTS OF PRIMARY HEALTH CARE

Primary Health Care should, at a minimum, include the following:⁶

- Education concerning prevailing health problems and the methods of preventing and controlling them
- Promotion of food supply and proper nutrition
- Basic sanitation and adequate supply of safe water
- Maternal and child health care, including family planning
- Immunization against major infectious diseases
- Prevention and control of locally endemic diseases
- Appropriate treatment of common diseases and injuries
- Provision of essential drugs.

Countries can include any other services which they feel are essential at Primary Health Care level, in their own countries.

Primary Health Care involves, in addition to health, all related sectors of national and community development, especially agriculture, animal husbandry, food, industry, education, housing, public works, communication, etc. Coordination of all these sectors is essential.

Primary Health Care should be sustained by integrated, functional and mutually supportive referral systems. All levels of the health care delivery system should

support primary health care. Referral should not be visualized as a passive one-way approach. The patient should always continue to remain under care of his referring physician. The specialists should also endeavor to move down the referral ladder so that services are available at the periphery also.

Primary Health Care promotes the use of locally available, scientifically sound technology. This reduces costs and promotes local enterprise. Primary Health Care relies heavily on services of health workers and traditional practitioners who have been suitably trained. In India, a vast network exists for the delivery of primary health care. Village Health guides and trained 'Dais' are the peripheral workers providing primary health care services. They are supported by Health Workers at the subcenters and other staff at the higher levels of the referral network.

It was recommended that national strategies should take into account socioeconomic factors, available resources and the particular health problems and needs of the people, with initial emphasis on underserved areas. Community participation was greatly emphasized as a means to achieve health for all. Community participation is the process by which individuals and families assume responsibility for health and welfare for themselves, as also for the community in which they live, and develop the capacity to contribute to their own and the community's development. This enables them to become agents of their own development, instead of remaining passive beneficiaries.

A series of indicators of progress towards the goal of Health for All have been developed as already mentioned.

Rural Primary Health Care

Background

The Bhore Committee⁷ recommended that an integrated health service comprising primary health units, secondary health units and district health units should be established. This service should provide all facilities of medical and health care including ambulance, hospitals, laboratories and various specialists. This recommendation had to be implemented through a long-term program over a period of 30 to 40 years and through an immediate short-term program over a period of 10 years.

The long-term program envisaged a three-tier system of health units as follows:

1. A 75 bedded Primary Health Unit or Centre (PHU or PHC) for 10 to 20,000 population. The recommended staff consisted of 6 medical officers, 2 sanitary inspectors, 6 public health nurses, 2 health assistants and 11 ancillary staff.
2. A 550 bedded secondary health unit to cover about 30 PHUs was proposed. The staff included an administrative officer and full time heads of departments of medicine, surgery, maternity, tuberculosis and pathology.

3. A 2,500 bedded district health unit at the district head quarter to provide cover to 10 to 30 lakh population was envisaged.

The above three types of health units were to be connected by telephone and ambulance. A little calculation shows that the structure proposed above provides for 7.5 beds per 1000 population, taking the district population as 20 lakh and the PHU population as 15,000. This is approximately twice the present number of 4.1 beds per 1000 population in Kolkata, the comparable figures for Delhi, Chennai and Greater Mumbai being 2.1, 3.2 and 3.3 respectively.⁵ It may be mentioned that in a neighboring country, Mongolia, there are 10.14 beds and 2.05 doctors for every 1000 population,⁶ the comparable figure in India being 0.93 beds and 0.45 doctors per 1000 population.⁸

The short-term program for action over a period of 10 years proposed that the PHC should cover 40,000 population and should have 30 beds. The staff included two medical officers, five nurses, 4 midwives, 4 trained dais, two sanitary inspectors and other support personnel. A secondary health unit was proposed for each subdivision of the district. Suitable strengthening of the existing district hospital was also suggested.

The implementation of the recommendations of the Bhore Committee report submitted at the eve of independence had to wait for some years due to many reasons, the main reason being shortage of funds and trained personnel. The Central Council of Health, at its first meeting held in January, 1953, fully endorsed the principle of integrated community development and accepted the provision of a primary health unit in each Block as an essential part of Community Development Program. A primary health center was intended to provide health care, both curative and preventive, and to serve as a focus from which health services radiate into the area covered by the Community Development Block. Now these PHCs form the core of National Health Planning.

Evolution of Primary Health Centers

The staffing pattern initially proposed for the PHC in each CD Block consisted, besides other personnel, of two each of medical officers, lady health visitors and sanitary inspectors. However, because of acute shortage of personnel, the government had to scale down the recommended staff to one each in the above categories. The development of the PHC system still remained very slow due to various constraints. In view of this, there was incorporated in the Fifth Plan a Minimum Needs Program (MNP) to be operated through the State Governments, the objectives of which were as following:

- Establishment of one Primary Health Center for each 1,00,000 population
- Establishment of one subcenter for every 10,000 population

- Making up the deficiencies in buildings, including residential quarters of the existing Primary Health Centers and subcenters
- Provision of drugs at the scale of Rs. 12,000 per annum per Primary Health Center and Rs. 2,000 per annum per subcenter
- Upgradation of one in every 4 primary health centers to the status of a 30 bed rural hospital with specialized services in surgery, medicine, obstetrics and gynecology.

The above targets set under the MNP could not be fulfilled during the fifth plan (1974-79). In 1983, the National Health Plan was formulated, under which the PHCs were to be reorganized on the basis of one PHC for 30,000 population (20,000 in tribal, hilly and backward areas). The staffing pattern of the PHC and subcenters according to the reorganized pattern is given **Tables 28.1 and 28.2** respectively. The new feature to be noted in the new PHC is the provision for a Community Health Officer (CHO). The CHO would be selected from the supervisory staff at PHC and District Level, and would be provided training for a period of 6-9 months. CHOs would be responsible for providing supervision, support and guidance to all health personnel and community health level workers in implementation of health, family welfare and MCH Programs.⁵ As of October 2000, 22,975 PHCs as against a requirement of 25,361 PHCs and 2,935 CHC as against a projected requirement of 6,337 CHCs were functioning in the country.⁹

Unfortunately population covered by PHC and SC is much more than the recommended norm.

Some of the factors identified by the Planning Commission for the suboptimal functioning of primary health care institutions are as follows:

- Inappropriate locations, poor access and poor maintenance.
- Gaps in critical manpower
- Mismatch between personnel and equipment
- Lack of essential drugs/diagnostics and poor referral linkages.

The Ninth Plan has given high priority for improving the functioning status and efficiency of operation of the primary health care infrastructure by:

- Ensuring that the existing subcenters and primary health centers are made fully operational.
- Filling the gaps in Community Health Centers through restructuring existing block level PHC and taluk, subdivisional hospitals.
- Providing need based manpower on the basis of distances, difficulties and workload.
- Providing essential equipment, consumables and drugs.
- Establishing functional referral linkages.

Some States like HP have already undertaken the restructuring on these lines. The Ninth Plan targets that the gaps will be completely filled by 2002.

To fill the gaps in shortages of medical officers in the remote PHCs, the Ninth Plan suggested innovations like part-time doctors, adoption by industrial establishments, cooperatives, self-help groups and charitable institutions and permitting local practitioners to pay a rental and practice in the PHCs after OPD hours. The usefulness of these approaches is being assessed.

TABLE 28.1: New staffing pattern of PHC

• Medical officer	1
• Community health officer	1
• Pharmacist	1
• Nurse midwife (staff nurse)	1
• ANM	1
• Health educator (Block extension educator)	1
• Health assistant (Male)	1
• Health assistant (Female)	1
• UDC	1
• LDC	1
• Lab. technician	1
• Driver (Subject to availability of vehicle)	1
• Class IV	4
Total	16

Population served: 30,000 (20,000 in tribal, hilly and backward areas).

TABLE 28.2: New staffing pattern of health subcenters

Health worker (Male)	1
Health worker (Female)	1
Voluntary worker (monthly honorarium Rs. 50/-)	1
Total	3

Population served: 6,000 (3,000 in tribal, hilly and backward areas). Six subcenters are located in each PHC area.

Functions of the PHC

The Primary Health Center is responsible for performing a number of functions as follows:

- Medical care including referral and laboratory services.
- Control of communicable diseases.
- Environmental sanitation with priority for provision of safe water supply and sanitary disposal of human excreta.
- Maternal and Child Health Services (MCH).
- Family Planning.
- School Health Service.
- Health Education.
- Collection of Vital Statistics.
- Implementing the National Health Programs.
- Training of Personnel.

MEDICAL CARE, REFERRAL AND LABORATORY SERVICES

A large number of outpatients are treated at the PHC. Records of all cases should be maintained and diseases affecting the family or the community should be taken special note of. The Medical Officer conducts OPD

every morning. In the afternoon, he has to visit the subcenters by rotation, where he provides curative treatment and guides the midwife in her MCH duties. He also has to attend to school health program, check the records and performance of the Health Assistant or Sanitary Inspector, and visit villages for specific tasks. The Medical Officer has a vehicle to move in the area and to shift maternity and other cases to the referral hospital.

In the old pattern PHC, the second Medical Officer helps the Medical Officer (Incharge) PHC in performing various duties which include, in addition to the above, taking care of the indoor patients, which may be either maternity cases or general emergency cases. The Medical Officers divide amongst themselves the PHC and field duties according to a mutually convenient schedule. In the new PHC pattern, the second medical officer is sought to be replaced by a new cadre of worker, the Community Health Officer. The CHO is a gazetted, nonmedical post, to be filled up mostly by promoting the existing health assistants. He is supposed to render administrative and supervisory support so that the single Medical Officer can carry out his health obligations without any impediment.

Unfortunately, various states have not accepted the above PHC staffing pattern as regards the post of Community Health Officer. Most states have opted to substitute the post of CHO by another MO. Had the post of CHO been retained, it would not only have left more time for the Medical Officer to devote for medical work but, would also, have opened avenues for upward mobility of various categories of health staff. In the ultimate analysis, availability of a senior gazetted post to nonmedical personnel would have meant that more capable and committed persons would join the rural health services.

CONTROL OF COMMUNICABLE DISEASES

Communicable diseases still form the most important public health problem in India. Large scale eradication and control campaigns have been undertaken at Central and State levels through special organizations in respect of malaria, filaria, tuberculosis, leprosy, etc. The staff of PHC has to help and cooperate in the execution of these programs. Also, the PHC staff has to be vigilant about the outbreak of cholera, food poisoning, typhoid, dysentery and infective hepatitis, etc. and take prompt steps regarding the same.

Routine immunization has to be arranged against tuberculosis, diphtheria, whooping cough, tetanus and poliomyelitis and measles as per the guidelines of the Universal Immunization Program (UIP). Antirabies vaccine and serum, as also antitetanic, antidiphtheric and antsnake venom sera, should also be available at the PHC. It is proposed to provide VDRL testing facilities at all PHCs to help in treatment and control of sexually transmitted diseases. HIV/AIDS control is now of primary concern in many States.

ENVIRONMENTAL SANITATION AND SAFE WATER SUPPLY

The efforts in this direction include education, guidance and help to the community as regards the following:

- Provision of safe and wholesome water supply by construction of new sanitary wells and tanks, repair of the old ones, maintenance of hand-pumps and periodical disinfection of water by the use of bleaching powder.
- Disposal of human excreta by construction of cheap, simple and sanitary latrines. Handflush water-seal latrine is considered to be the best but aqua privy, septic tank and trench latrines may also be indicated sometimes. Installation of biogas plants should be encouraged.
- Disposal of sullage water through soakpits, nonleaching cesspits or kitchen gardens.
- Disposal of refuse by filling, burning or composting.
- Use of smokeless chulas.
- Antimalaria, antily and antirodent measures.

MCH SERVICES

Antenatal and natal services were traditionally provided by untrained *dais*. The proportion of deliveries conducted by trained birth attendants has now increased up to 48.8% as in 1993.⁸ This has been possible largely through the PHC system. A special focus was given to MCH services under the Child Survival and Safe Motherhood Program, now forming part of the RCH program.

FAMILY PLANNING

Importance of family planning as a means of population stabilization and health promotion cannot be over-emphasized. Family welfare has two components—MCH and Family Planning. Both are of crucial importance for the health and welfare of the family. The staff of the PHC has to play a major role for making the family planning program a success.

SCHOOL HEALTH SERVICE

The PHC Medical Officer is expected to organize an active school health service for school students. This has not been possible in practice so far. It is expected that this activity may improve in the reorganized PHC set-up. Details about school health service are given in Chapter 32.

HEALTH EDUCATION

Health education, like general education, is concerned with the change in knowledge, attitudes and behavior of people. It should be imparted by all PHC personnel at all possible opportunities through individual or group contact with the community.

Such opportunities should be particularly sought during the course of MCH and family planning work. The schools also provide a very important forum for providing health education. Health education is the responsibility of the whole PHC team, hence the Medical Officer should train his team in proper educational techniques. Besides giving lectures on health topics, he should also seize teaching opportunities when treating patients. Village Health Committees should be formed and healthful ways of living should be propagated through them.

VITAL STATISTICS

Correct records of vital events such as births, deaths, infants and maternal deaths, causes of death and morbidity rates of various diseases in the area reflect the efficiency of a PHC. The sanitary inspector, health inspectors and health assistants should check the village registers and find omissions of births by comparing them with their immunization records and antenatal, infant and toddler cases.

Such omissions should be properly entered and the cause of death corrected, if necessary. They should help the village registrars (e.g. Sarpanch, Panchayat Secretary, Village Munsif, Police Patel, etc.) in methods of registration, keeping of records and making reports. Registers on epidemic disease should be checked and properly maintained.

NATIONAL HEALTH PROGRAMS

A large number of national programs have been launched to improve the health of people. The more important among these are the Family Welfare Program, UIP (Universal Immunization Program) and the programs for control of malaria, filaria, leprosy, tuberculosis, goiter and visual impairment. These programs have to be implemented at the block level by the PHC and it is the responsibility of the Medical Officer Incharge PHC to ensure that this is done properly.

TRAINING OF PERSONNEL

The MO, PHC is responsible for in-service training of his staff in order to ensure their best performance. In addition to such continued education, the MO is also responsible for providing training to other personnel outside the PHC staff. Examples of such training are:

- Training to village health guides
- Training to anganwadi workers in ICDS blocks
- Training to school teachers as part of the school health program
- Training to untrained *dais*.

Duties of the PHC Medical Officer

GENERAL

He is responsible for all curative and preventive health work in his area, i.e. for the functions of the PHC described above. His clinical duties include:

- Organizing and conducting the outpatient clinics at PHC
- Organization of the indoor service
- Attending to medicolegal cases
- Attending to emergency cases
- Organizing the laboratory service at the PHC
- Referring cases to hospital.

SUPERVISORY

He supervises and guides the work of other members of the staff. He visits subcenters and other villages for this purpose.

ADMINISTRATIVE

He coordinates and cooperates with other health agencies and voluntary organizations working in the area. He enlists cooperation of other departments such as revenue, agriculture, education and Public Health Engineering for promotion of health and prevention of disease. More specifically, his administrative duties are as follows:⁵

- Guiding and checking the preparation of tour programs of staff.
- All matters relating to management of personnel.
- Reporting the progress of activities under all programs to the Chief Medical Officer.
- Liaison with other officials and agencies in the block
- All matters relating to indents, receipts and maintenance of supplies.

Rural Health Training Centers

Some of the primary health units near the medical colleges are utilized for training undergraduate medical students, interns, sanitary inspectors, health visitors and nurses in the practice of preventive and social medicine in rural areas of the country. For this training, there is a separate organization called 'Rural Health Training Centre' at the headquarter of PHC. The RHTC has its own training staff, including, among others, a Medical Officer and a functionary of the public health engineering department. This staff is stationed mostly at the headquarter while some members are posted at the subcenters.

Rural Health Scheme

The Rural Health Scheme emerged out of the recommendations of the Shrivastav Committee and was introduced in 1977. It is based on a 4-tier system of services provided at the level of the village, the subcenter, the PHC and the CHC as described below:

VILLAGE LEVEL

73.9% of India's population lived in nonurban areas in 1991.⁸ 37.3% of the rural population lives below the poverty line in contrast to 32.4% in urban areas.⁸ As per the provisional totals of the 2001 census, the literacy rate for males is 75.96% and for females it is 54.28%.¹⁰ 23% villages in India still do not have electricity.⁴ In these conditions, it is not surprising that health facilities are meagre in the villages. It is not possible for a physician to be available in each village for providing health care to the villagers. The Rural Health Scheme was hence envisaged to enlist local people in the health service set-up. Two types of functionaries were sought to be developed for this purpose, viz., the Health Guide and the Trained Dais.

Village Health Guides

On October 2, 1977 the Community Health Workers Scheme was launched in India to provide health services to people in the villages by enlisting people's participation. The name of this cadre of worker was later changed from Community Health Worker (CHW) to Village Health Guides (VHG). This scheme is in operation in all states and Union Territories except in four states where alternative rural health schemes are in progress. These states and their schemes are as follows: Jammu and Kashmir (Rehbar-e-Sehat), Arunachal Pradesh (Medics), Tamil Nadu (Mini Health Centres) and Kerala (strengthening of PHCs).

The health guide is envisaged as a person from within the community who provides primary health care to the people in the village. As such, following guidelines for appointing the health guides are observed:

- He or she should be a permanent resident in the village.
- He or she should be acceptable to all sections of the community.
- He or she should have had formal education up to at least sixth standard. This criterion can be relaxed if the candidate is otherwise suitable.
- He or she should be able and willing to spare 2 to 3 hours daily for community health work.

The health guide is given 3 months training at the PHC. During the training period, he gets Rs. 200 per month and is taught basic health concepts including treatment of minor ailments, first aid, environmental sanitation, family planning, personal hygiene and

principles of health education. At the end of the training, the health guides are given a certificate, a manual and a kit. The manual tells them in simple words what to do and what not to do in the situations they might face. The kit contains common medicines (modern as well as indigenous) needed in the community. After the training, the health guide attends to people's problems in his spare time, while continuing to attend to his other normal vocation. He is paid Rs. 50/- per month as honorarium for this voluntary work. His stock of medicines is also periodically replenished, the annual supply being Rs. 600/- worth of medicines.

The health guide is to be selected by the Gram Panchayat. He reports to a Village Health Committee, consisting of 5 members, on all matters except technical ones, which are referred to the concerned Medical Officer. Usually one VHG is provided for 1000 population (500 in case of tribal, hilly or remote areas). If the population of a village is more than 2000, two guides can be provided. One of these should be a woman, and one should be from a Scheduled Caste/Tribe. The government took a policy decision in 1986 to replace male VHGs by female VHGs.

Preference is to be given to practising dais. The health guide cannot administer injections and cannot prescribe outside the list of drugs provided to him. He should not treat any case for more than 2 days if there is no improvement.

Trained Dais

Almost all deliveries in the villages are conducted in the homes, unattended by a doctor or a properly trained health functionary. The high maternal mortality rate and neonatal tetanus mortality rates are largely due to lack of proper antenatal, natal and postnatal care. If the basic concepts of such care are imparted to the local indigenous village dai, high maternal morbidity and mortality can be reduced. This is the idea behind the dai training scheme. The target is to train one local dai per village or per 1000 population. The training lasts for one month. The trainees get a stipend of Rs. 300/- during this period. The training is imparted 2 days in a week at the PHC/subcenters and 4 days in a week in the field, when the dai accompanies the Health Worker (Female) to the village. During the one month training, the dai has to conduct at least 2 deliveries under the supervision of the Health Worker (Female). At the end of the training, she is given a Dai's Kit which she can use for conducting deliveries. There is a provision to pay her Rs. 2/- per delivery, provided the case has been registered at the subcenter or the PHC". This is only to facilitate registration of births. The Dai is free to charge the community for her services.

A new scheme for training of dais has been initiated in January 2001 to tackle the problem of unsafe

deliveries in 142 districts in 17 States, where safe delivery rates were less than 30%. The States include Assam, Arunchal Pradesh, Bihar, Gujarat, J and K, Jharkhand, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Rajasthan, Sikkim, Uttar Pradesh, Uttaranchal and West Bengal.⁹

SUBCENTER LEVEL

In the public sector, a Subcenter (Subhealth Center) is the most peripheral and first contact point between the primary health care system and the community. As per the population norms, one subcenter is established for every 5000 population in plain areas and for every 3000 population in hilly/tribal/desert areas. It is the lowest rung of a three-tier set-up consisting of the Subcenter established for every 3000-5000 population with referral linkage to the Primary Health Center (PHC) for 20,000–30,000 population, and the Community Health Centre (CHC) for 80,000 to 1,20,000 population. There are 146036 Subcenters functioning in the country as per Rural Health Statistics Bulletin published in July, 2009.¹¹

A subcenter provides all the primary health care services such as immunization, antenatal, natal and postnatal care, prevention of malnutrition and common childhood diseases, family planning services and counseling. They also provide elementary drugs for minor ailments such as ARI, diarrhea, fever, worm infestation, etc. and carryout community needs assessment. Besides these, several national health and family welfare programs are delivered through these frontline workers.

Health Workers

Currently a subcenter is staffed by one Female Health Worker commonly known as Auxiliary Nurse Midwife (ANM) and one Male Health Worker commonly known as Multi Purpose Worker (Male). For this, the unipurpose workers were to undergo a training for 6 to 8 weeks (6 weeks for females and 8 weeks for males). One Health Assistant (Female) commonly known as Lady Health Visitor (LHV) and one Health Assistant (Male) located at the PHC level are entrusted with the task of supervision of all the subcenters (generally six subcenters) under a PHC. Most health assistants are the former health visitors, malaria inspectors, health inspectors and sanitary inspectors, who have undergone 8 to 10 weeks in-service training.

IPHS for Subcenters

In order to provide Quality Care in these subcenters, Indian Public Health Standards (IPHS) are being prescribed to provide basic primary health care services to the community. These standards would help monitor

and improve functioning of the subcenter. Currently the IPHS for subcenters has been prepared keeping in view the resources available with respect to functional requirement for subcenters with minimum standards, such as building, manpower, instruments and equipment, drugs and other facilities, etc.¹²

Service delivery:

- i. All “Assured Services” as envisaged in the subcenters should be available, which includes routine, preventive, promotive, few curative and referral services in addition to all the national health programs as applicable.
- ii. All the support services to fulfill the above objectives will be strengthened at the subcenters level.

Services to be provided in a Subcenter:

Subcenters are expected to provide promotive, preventive and few curative primary health care services as below:

The following are the services to be provided through subcenter which have been classified as Essential (Minimum Assured Services) or Desirable (that all States/UTs should aspire to achieve).

1. Maternal and child health:

Maternal Health

i. Antenatal care: Essential

- Early registration of all pregnancies, within first trimester (before 12th week of pregnancy). However even if a woman comes late in her pregnancy for registration, she should be registered and care given to her according to gestational age.
- Minimum 4 ANC including Registration Suggested schedule for antenatal visits
 - 1st visit:** Within 12 weeks—preferably as soon as pregnancy is suspected—for registration of pregnancy history, and first antenatal check-up
 - 2nd visit:** Between 14 and 26 weeks
 - 3rd visit:** Between 28 and 34 weeks
 - 4th visit:** Between 36 weeks and term
- Associated services like general examination such as height, weight, BP, anemia, abdominal examination, breast examination, Folic Acid Supplementation in first trimester, Iron and Folic Acid Supplementation from 12 weeks, injection tetanus toxoid, treatment of anemia, etc.
- Recording tobacco use by all antenatal mothers
- Minimum laboratory investigations like Urine Test for pregnancy confirmation, hemoglobin estimation, urine for albumin and sugar and linkages with PHC for other required tests.
- Name based tracking of all pregnant women for assured service delivery.
- Identification of high risk pregnancy cases.
- Identification and management of danger signs during pregnancy.

- Malaria prophylaxis in malaria endemic zones for pregnant women as per the guidelines of NVBDCP.
- Appropriate and Timely referral of such identified cases which are beyond her capacity of management.
- Counseling on diet, rest, tobacco cessation if the antenatal mother is a smoker or tobacco user, information about dangers of exposure to second hand smoke and any minor problem during pregnancy, advice on institutional deliveries, pre birth preparedness and complication readiness, danger signs, clean and safe delivery at home if called for, postnatal care and hygiene, nutrition, care of newborn and registration of birth. Initiation of breast feeding, exclusive breastfeeding for 6 months, demand feeding, supplementary feeding (weaning and starting semi solid and solid food) at 6 months, infant and young child feeding, contraception.
- Provide information about provisions under current schemes and programs like Janani Suraksha Yojana.
- Identification and basic management of STI/RTI.
- Counseling and referral for HIV/AIDS.

ii. Intranatal care: Essential

- Promotion of institutional deliveries
- Skilled attendance at home deliveries when called for
- Appropriate and Timely referral of high-risk cases which are beyond her capacity of management

Essential, if delivery facilities are available

- Managing labor using Partograph
- Identification and management of danger signs during labor.
- Proficient in identification and basic first aid treatment for PPH, Eclampsia, Sepsis and prompt referral of such cases.
- In case of subcenter delivery, minimum 6 hours of stay of mother and baby.

iii. Postnatal care: Essential

- Initiation of early breastfeeding within one hour of birth
- Ensure postnatal home visits on 0,3,7 and 42nd day for deliveries at home and subcenter (both for mother and baby).
- Ensure 3, 7, and 42nd day visit for institutional delivery (both for mother and baby).
- In case of low birth weight baby (less than 2500 gm), additional visits are to be made on 14, 21 and 28th days.
- During postnatal visit, Advice regarding care of the mother and care and feeding of the newborn and examine the newborn for signs of sickness and congenital abnormalities as per IMNCI Guidelines and appropriate referral, if needed.
- Counseling on diet and rest, hygiene, contraception, essential newborn care, infant and young child feeding, and STI/RTI and HIV/AIDS.
- Tracking of missed and left out PNC.

Child health: Essential

- Newborn Care Corner In The Labor Room to provide Essential Newborn Care: Essential If the Deliveries take Place at the Subcenter
Essential Newborn Care (maintain the body temperature and prevent hypothermia (provision of warmth/Kangaroo Mother Care (KMC), maintain the airway and breathing, initiate breastfeeding within one hour, infection protection, cord care, and care of the eyes.
- Promotion of exclusive breastfeeding for 6 months and complementary feeding after 6 months as per Infant and Young Child Feeding (IYCF) Guidelines.
- Assess the growth and development of the infants and under 5 children and make timely referral.
- Immunization services: Full immunization of all infants and children against vaccine preventable diseases as per guidelines of Government of India.
- Vitamin A prophylaxis to the children as per National guidelines.
- Prevention and control of childhood diseases like malnutrition, infections, ARI, diarrhea, fever, anemia, etc. including IMNCI strategy.
- Name based tracking of all infants and children as per immunization program.
- Identification and follow-up, referral and reporting of Adverse Events Following Immunization (AEFI).

2. Family planning and contraception: Essential

- Education, Motivation and counseling to adopt appropriate Family planning methods
- Provision of contraceptives such as condoms, oral pills, emergency contraceptives, IUD insertions (wherever the ANM is trained on IUD insertion)
- Follow-up services to the eligible couples adopting any family planning methods (terminal/spacing).

3. Safe abortion services (MTP): Essential

- Counseling and appropriate referral for safe abortion services (MTP) for those in need
- Follow-up for any complication after abortion/MTP.

4. Curative services: Essential

- Provide treatment for minor ailments including fever, diarrhea, ARI, worm infestation and First Aid including first aid to animal bite cases [wound care, tourniquet (in snake bite) assessment and referral].
- Appropriate and prompt referral.
- Provide treatment as per AYUSH as per the local need. ANMs and MPW (M) be trained in AYUSH.

5. Adolescent health care: Desirable

- Education, counseling and referral
- Prevention and treatment of anemia
- Counseling for tobacco cessation.

6. School health services: Desirable

- Staff of subcenter may provide Assistance to school health services

7. Control of local endemic diseases: Essential

- Assisting in detection, Control and reporting of local endemic diseases such as malaria, Kala-azar, Japanese encephalitis, Filariasis, Dengue, etc.
- Assistance in control of epidemic outbreaks as per program guidelines.

8. Disease surveillance (Integrated disease surveillance project) (IDSP): Essential

- Surveillance about any abnormal increase in cases of diarrhea/dysentery, fever with rigors, fever with rash, fever with jaundice or fever with unconsciousness and early reporting to concerned PHC as per IDSP guidelines
- Immediate reporting of any cluster/outbreak based on syndromic surveillance.
- High level of alertness for any unusual health event, reporting and appropriate action.
- Weekly submission of report to PHC in 'S' Form as per IDSP guidelines.

9. Water and sanitation: Desirable

- Disinfection of drinking water sources
- Promotion of sanitation including use of toilets and appropriate garbage disposal.

10. Out reach/field services

Village Health and Nutrition Day (VHND) should be organized at least once in a month in each village with the help of Medical Officer, Health Assistant Female (LHV) of PHC, HWM, HWF, ASHA, AWW and their supervisory staff, PRI, self help groups, etc. Each Village Health and Nutrition Day should last for at least four hours of contact time between ANMs, AWWs, ASHAs and the beneficiaries.

The services to be provided at VHND are listed below:

Essential

- Early registration and antenatal care for pregnant women—as per standard treatment protocol for the SBA
- Immunization and vitamin A administration to all under 5 children as per immunization schedule
- Assessment, treatment, counseling, referral as per need for all cases of malnutrition in children less than 5 years identified by AWW
- Family planning counseling and distribution of contraceptives
- Symptomatic care and management of persons with minor illness referred by ASHAs/AWWs or coming on their own accord.
- Health Communication to mothers, adolescents and other members of the community who attend the clinic for whatever reason.
- Meet with ASHAs and provide training/support to them as needed.
- Registration of Birth and Deaths.

11. Home visits: Essential

- For skilled attendance at birth—where the woman has opted or had to go in for a home delivery.

- Postnatal and newborn visits—as per protocol
- To check out on disease incidences reported to HW or she/he comes across during house visits—especially where there it is a notifiable disease. Notify the MO PHC immediately about any abnormal increase in cases of diarrhea/dysentery, fever with rigors, fever with rash, flaccid paralysis of acute onset in a child <15 years (AFP), wheezing cough, tetanus, fever with jaundice or fever with unconsciousness, minor and serious AEFIs which she comes across during her home visits, take the necessary measures to prevent their spread.

12. House-to-house surveys

These surveys would be done once annually, preferably in April. Some of the diseases would require special surveys- but at all times not more than one survey per month would be expected. The following things are prepared:

Essential

- Age and sex of all family members.
- Assess and list eligible couples and their unmet needs for contraception.
- Identify persons with skin lesions or other symptoms suspicious of leprosy, and refer: essential in high leprosy prevalence blocks.
- Identify persons with blindness, list and refer: Identify persons with deafness, list and refer.
- Mass drug administration for filarial—in endemic area.

13. Community level interactions: Essential

- Focal group discussions for information gathering and health planning.
- Health Communication especially as related to National Health programmes through attending Village health and sanitation committees, ASHA local review meetings, and meetings with panchayat members/sarpanch, self help groups, women's groups and other BCC activities.

14. National Health Programs:**(A) Communicable Disease Program**

- a. National AIDS Control Programme (NACP): Essential
 - Condom promotion and distribution of condoms to the high risk groups.
 - Help and guide patients with HIV/AIDS receiving ART with focus on adherence
 - IEC activities to enhance awareness and preventive measures about STIs and HIV/AIDS, PPTCT services and HIV-TB coordination.
- b. National Vector Borne Disease Control Programme (NVBDCP): Essential
 - Collection of Blood slides of fever patients
 - Rapid Diagnostic Tests (RDT) for diagnosis of Pf malaria in high Pf endemic areas.
 - Appropriate anti-malarial treatment.
 - Assistance for integrated vector control activities in relation to Malaria, Filariasis, JE, Dengue, Kala-azar, etc. as prevalent in specific areas. Prevention

of breeding places of vectors through IEC and community mobilization. Where filaria is endemic, identification of cases of lymphedema/elephantiasis and hydrocele and their referrals to PHC/CHC for appropriate management. The disease specific guidelines issued by NVBDCP are to be followed.

- Promotion of use of insecticidal treated nets, wherever supplied.
 - Record keeping and reporting as per program guidelines.
- c. National Leprosy Eradication Programme (NLEP): Essential
- Health education to community regarding signs and symptoms of leprosy, its complications, curability and availability of free of cost treatment
 - Referral of suspected cases of leprosy (person with skin patch, nodule, thickened skin, impaired sensation in hands and feet with muscle weakness) and its complications to PHC
 - Provision of subsequent doses of MDT and follow-up for persons under treatment for leprosy, maintain MLF-01 and monitor for regularity and completion of treatment
- d. Revised National Tuberculosis Control Programme (RNTCP): Essential
- Referral of suspected symptomatic cases to the PHC/Microscopy center
 - Provision of DOTS at subcenter and proper documentation and follow-up.
 - Care should be taken to ensure compliance and completion of treatment in all cases.
 - Adequate drinking water should be ensured at subcenter for taking the tablets.
- (B) Noncommunicable Disease (NCD)**
Programs:
- a. National Blindness Control Programme (NBCP): Essential
- Detection of cases of impaired vision in house to house surveys. The cases with decreased vision will be noted in the blindness register.
 - Spreading awareness regarding eye problems, early detection of decreased vision, available treatment and health care facilities for referral of such cases. IEC is the major activity to help identify cases of blindness and refer suspected cataract cases.
- b. National Programme for Prevention and Control of Deafness (NPPCD): Essential
- Detection of cases of hearing impairment and deafness during house to house survey.
 - Awareness regarding ear problems, early detection of deafness, available treatment and health care facilities for referral of such cases.
 - Education of community, especially the parents of young children regarding importance of right feeding practices, early detection of deafness in young children, common ear problems and available treatment for hearing impairment/deafness.
- c. National Mental Health Programme: Essential
- Identification and referral of common mental illnesses for treatment and follow them up in community.
 - IEC activities for prevention and early detection of mental disorders and greater participation/ role of Community for primary prevention of mental disorders.
- d. National Cancer Control Programme and National Programme for prevention and Control of Diabetes, CVD and Stroke: Essential
- IEC Activities to promote healthy lifestyle sensitize the community about prevention of Cancers, Diabetes, CVD and Strokes, early detection through awareness regarding warning signs and appropriate and prompt referral of suspect cases.
- e. National Iodine Deficiency Disorders Control Programme: Essential
- IEC Activities to promote consumption of iodized salt by the community. Testing of salt for presence of Iodine through Salt Testing Kits by ASHAs.
- f. In Fluorosis Affected (Endemic) Areas: Essential
- Identify the persons at risk of Fluorosis, suffering from Fluorosis and those having deformities due to Fluorosis and referral.
- g. National Tobacco Control Programme: Essential
- Spread awareness and health education regarding ill effects of tobacco use especially in pregnant females, and Noncommunicable disease where tobacco is a risk factor, e.g. Cardiovascular disease, cancers, chronic lung diseases
 - Display of mandatory signage of “No Smoking” in the subcenter.
- h. Oral Health: Desirable
- Health education on oral health and hygiene especially to antenatal and lactating mothers, school and adolescent children
 - Providing first aid and referral services for cases with oral health problems.
- i. Disability Prevention: Desirable
- Health education on Prevention of Disability
 - Identification of Disabled persons during annual house to house survey and their appropriate referral.
- j. National Programme for Health Care of Elderly: Desirable
- Counseling of elderly persons and their family members on healthy aging.
 - Referral of sick old persons to PHC.
- Physical infrastructure:** A Subcenter should have its own building. If that is not possible immediately, the premises with adequate space should be rented in a central location with easy access to population.

1. *Location of the center:* For all new upcoming subcenters, following may be ensured.
 - Subcenter to be located within the village for providing easy access to the people and safety of the ANM.
 - As far as possible no person has to travel more than 3 km to reach the subcenter.
 - The subcenter village has some communication net work (road communication/public transport/post office/telephone)
 - SC should be away from garbage collection, cattle shed, water logging area, etc.
 - While finalizing the location of the subcenter, the concerned Panchayat should also be consulted.
2. *Building and lay out:* Boundary wall/fencing: Boundary wall/fencing with Gate should be provided for safety and security.
3. *Signage:* The building should have a prominent board displaying the name of the center in the local language at the gate and on the building.
4. Disaster prevention measures against earthquake, flood and fire (Desirable for all new upcoming facilities) should be there.
5. *Environment friendly features:* The SC should be, as far as possible, environment friendly and energy efficient. Rain-water harvesting, solar energy use and use of energy-efficient bulbs/equipment should be encouraged.

Available Drugs

Drug kit A and B are available (**Table 28.3**), apart from additional drugs required for skilled attendance at birth (Inj. Oxytocin, Cap. Ampicillin, Tab. Metronidazole, Tab. Misoprostol 200 µ, etc.), other drugs and vaccines (Syrup Cotrimoxazole, Syrup Paracetamole, Tab. Albendazole, BCG, DPT, OPV, Measles, etc.).

TABLE 28.3: Drug kit A and B for subcenter

Drug kit 'A'	Drug kit 'B'
1. Oral rehydration salt	1. Tab. and Injection Methylergometrine Maleate
2. Tablet IFA (large and small)	2. Tab. Paracetamole (500 mg)
3. Vitamin A solution	3. Tab. Mebendazole (100 mg)
4. Tab. Cotrimoxazole (pediatric)	4. Tab. Dicyclomine HCl. (10 mg)
	5. Ointment Povidone Iodine 5%
	6. Cetrimide powder
	7. Cotton bandage
	8. Absorbant cotton (100 gm each)

Registers in Subcenter

The following registers are being maintained at subcenters. Eligible Couple Register including Contraception, Maternal and Child Health Register, Births and Deaths Register, Drug Register, Equipment Furniture and other accessories Register, Communicable diseases/ Epidemic Register, Passive surveillance register

for malaria cases, Register for records pertaining to Janani Suraksha Yojana, Register for maintenance of accounts including untied funds, Register for water quality and sanitation, Minor ailments Register, Records/ registers as per various National Health Programme guidelines (NLEP, RNTCP, NVBDCP, etc.)

Manpower Requirement

In order to provide above services, each subcenter should have the following personnel.¹¹

The manpower that should be available in the SCs (IPHS 2010) as follows:

Manpower	Existing	Proposed
Health worker female (ANM)	1	2
Health worker male	1	1 (funded and appointment by the state government)
Voluntary worker to keep the Subcenter clean and assisting ANM. She is paid by the ANM from her contingency fund @Rs. 100/pm	1 (optional)	1 (optional)
Total	2/3	3/4

The staff of the subcenter will have the support of ASHA (Accredited Social Health Activists) wherever the ASHA scheme is implemented/similar functionaries at village level in other areas. ASHA is primarily a trained woman volunteer, resident of the village married/widow/divorced with formal education up to 8th standard preferably in the age group of 25-45 years. The general norm is one ASHA per 1000 population.

In order to ensure quality of services and patient satisfaction, it is essential to encourage community participation. To ensure accountability, the **Citizens' Charter** should be available in all subcenters; the objectives being: (i) to make available health care services and the related facilities for citizens, (ii) to provide appropriate advice, treatment, referral and support that would help to cure the ailment to the extent medically possible, and (iii) to redress any grievances in this regard.

Primary Health Center Level

The Bhole Committee in 1946 gave the concept of a PHC. PHCs are the cornerstone of rural health services—a first port of call to a qualified doctor of the public sector in rural areas for the sick and those who directly report or referred from subcenters for curative, preventive and promotive health care. It acts as a referral unit for 6 subcenters and refer out cases to 6 Community Health centers (CHCs-30 bedded hospital) and higher order public hospitals at subdistrict and district hospitals. It has 4-6 indoor beds for patients.

The nomenclature of a PHC varies from State to State that include a Block level PHCs (located at block HQ and covering about 100,000 population and with varying number of indoor beds) and additional PHCs/ New PHCs covering a population of 20,000-30,000, etc. All the block level PHCs are ultimately going to be upgraded as Community Health Centers with 30 beds for providing specialized services. There are 23458 PHCs functioning in the country as per Rural Health Statistics Bulletin published in July, 2009. The number of PHCs functioning on 24 × 7 basis are 8409 and number of PHCs where three staff Nurses have been posted are 6263 (as on 31-3-2010).^{13,14}

PHCs are not spared from issues such as the inability to perform up to the expectation due to (i) non-availability of doctors at PHCs; (ii) even if posted, doctors do not stay at the PHC HQ; (iii) inadequate physical infrastructure and facilities; (iv) insufficient quantities of drugs; (v) lack of accountability to the public and lack of community participation; (vi) lack of set standards for monitoring quality care, etc.

IPHS FOR PRIMARY HEALTH CENTERS

This has been prepared keeping in view the resources available with respect to functional requirement for Primary Health Center with minimum standards such as building manpower, instruments, and equipments, drugs and other facilities, etc.¹³

1. Medical care: Essential
 - a. OPD services: A total of 6 hours of OPD services out of which 4 hours in the morning and 2 hours in the afternoon. Time schedule will vary from state to state. Minimum OPD attendance should be 40 patients per doctor per day.
 - b. 24 hours emergency services: Appropriate management of injuries and accident, First Aid, Stabilization of the condition of the patient before referral, Dog bite/snake bite/scorpion bite cases, and other emergency conditions.
 - c. Referral services
 - d. In-patient services (6 beds)
2. Maternal and Child Health Care including family planning: Essential
 - a. Antenatal care: Same as subcenter.
 - b. Intranatal care: (24-hour delivery services both normal and assisted). In addition to services from subcenter, it provides the following: (i) Conducting of normal deliveries, (ii) Assisted vaginal deliveries including forceps/vacuum delivery whenever required, (iii) Manual removal of placenta, (iv) Appropriate and prompt referral for cases needing specialist care, (v) Management of Pregnancy Induced hypertension including referral, (vi) Pre-referral management (Obstetric first-aid) in Obstetric emergencies that need expert assistance (Training of staff for emergency management to be ensured). (vii) Minimum 48 hours of stay after delivery.
- c. Postnatal care: In addition to services from subcenter, it provides the following: (i) Education on nutrition, hygiene, contraception, essential newborn care, (ii) Others: Provision of facilities under *Janani Suraksha Yojana (JSY)*.
- d. Newborn care: Essential: Same as subcenter.
- e. Care of the child Essential: Same as subcenter.
- f. Family Planning Essential: Same as subcenter: In addition PHC provides (i) Permanent methods like Tubal ligation and vasectomy/NSV and its follow-up service, (ii) Counseling and appropriate referral for couples having infertility.
3. Medical Termination of Pregnancies Essential: Same as subcenter.
4. Management of Reproductive Tract Infections/ Sexually Transmitted Infections: Essential:
 - a. Health education for prevention of RTI/ STIs
 - b. Treatment of RTI/STIs
5. Nutrition Services (coordinated with ICDS) Essential:
 - a. Diagnosis of and nutrition advice to malnourished children, pregnant women and others.
 - b. Diagnosis and management of anemia, and vitamin A deficiency.
 - c. Coordination with ICDS.
6. School Health: Essential: Regular check ups including eye and dental appropriate treatment including deworming, referral and follow-ups.
7. Adolescent Health Care: Desirable: Lifestyle education, counseling, appropriate treatment.
8. Promotion of Safe Drinking Water and Basic Sanitation: Essential: Same as subcenter.
9. Prevention and control of locally endemic diseases like malaria, Kala-azar, Japanese, Encephalitis, etc. (Essential)
10. Collection and reporting of vital events (Essential)
11. Health Education and Behaviour Change Communication (BCC) (Essential)
12. Other National Health Programmes
 - a. Revised National Tuberculosis Control Programme (RNTCP) Essential: All PHCs to function as DOTS Centers to deliver treatment as per RNTCP treatment guidelines through DOTS providers and treatment of common complications of TB and side effects of drugs, record and report on RNTCP activities as per guidelines Facility for Collection and transport of sputum samples should be available as per the RNTCP guidelines.
 - b. National Leprosy Eradication Programme Essential: Same as subcenter.

- c. Integrated Disease Surveillance Project (IDSP): Essential:
- i. Weekly reporting of epidemic prone diseases in S,P and L forms and SOS reporting of any cluster of cases (formats for the data collection are added in annexure 11, 11A, 11B, 11C.)
 - ii. PHC will collect and analyze data from subcenter and will report information to district surveillance unit.
 - iii. Appropriate preparedness and first level action in out-break situations.
 - iv. Laboratory services for diagnosis of Malaria, Tuberculosis, Typhoid (Rapid Diagnostic test-Typhi Dot) and tests for detection of fecal contamination of water (Rapid test kit) and chlorination level.
- d. National Programme for Control of Blindness (NPCB): Essential
Same as subcenters. In addition it provides the following: (i) Provision of Basic services for Diagnosis and treatment of common eye diseases, (ii) Greater participation/role of community in primary prevention of eye problems.
- e. National Vector Borne Disease Control Programme (NVBDCP): Essential in endemic areas
Diagnosis and Management of Vector borne Diseases is to be done as per NVBDCP guidelines for PHC/CHC. Same as subcenters. In addition it provides the following: (i) Cases of suspected JE and Dengue to be provided symptomatic treatment, hospitalization and case management as per the protocols, (ii) Complete treatment to kala-azar cases in kala-azar endemic areas as per national Policy, (iii) Complete treatment of microfilaria positive cases with DEC an participation and arrangement of Mass Drug Administration (MDA) along with management of side reactions, if any. Morbidity management of Lymphedema cases.
- f. National AIDS Control Programme: Essential
Same as subcenter. In addition, it provides the following: Organizing School Health Education Programme.
- g. National Programme for Prevention and Control of Deafness (NPPCD): Essential
Same as subcenter. In addition, it provides the following: Basic Diagnosis and treatment services for common ear diseases like wax in ear, otomycosis, otitis externa, Ear discharge, etc.
- h. National Cancer Control Programme (NCCP): Essential: Same as subcenter.
- i. National Mental Health Programme (NMHP): Essential: Same as subcenter. In addition, it provides the following: Early identification (diagnosis)and treatment of mental illness in the community Basic Services: Diagnosis and treatment of common mental disorders such as psychosis, depression, anxiety disorders and epilepsy and referral.
- j. National Programme on Prevention and Control of Diabetes, CVD and Stroke (NPDCS)
Essential:
- i. Health Promotion Services to modify individual, group and community behavior especially through:
 - Promotion of Healthy Dietary Habits.
 - Increase physical activity.
 - Avoidance of tobacco and alcohol.
 - Stress Management
 - ii. Early detection, management and referral of diabetes mellitus, hypertension through simple measures like history, measuring blood pressure, checking for blood urine sugar and ECG.
- k. National Iodine Deficiency Disorders Control Programme (NIDDCP): Essential: Same as subcenter.
- l. National Programme for Prevention and Control of Fluorosis (NPPCF) (In affected (Endemic) Districts): Essential: Same as subcenter.
- m. National Tobacco Control Programme (NTCP): Essential: In addition to subcenter activity, it provides the following. (i) Promoting quitting of tobacco in the community. (ii) Providing Brief advice on tobacco cessation to all smokers/tobacco users. (iii) Making PHC tobacco free.
- n. National Programme for Health Care of Elderly: Essential: Same as subcenter.
- o. Oral Health: Essential: Same as subcenter.
- p. Physical Medicine and Rehabilitation (PMR) Services Desirable
- i. Primary prevention of Disabilities
 - ii. Screening, early identification and detection
 - iii. Counseling
 - iv. Basic treatments like Exercise and Heat therapy, Range of Movement exercises, referral to higher centers and follow-up, etc.
 - v. Community based Rehabilitation Services
 - vi. Issue of Disability Certificate for obvious Disabilities by PHC doctor.

BASIC LABORATORY SERVICES

Essential laboratory services include:

- i. Routine urine, stool and blood tests (Hb%, platelets count, total RBC, WBC, bleeding and clotting time)
- ii. Diagnosis of RTI/ STDs with wet mounting, Grams stain, etc.
- iii. Sputum testing for mycobacterium (as per guidelines of RNTCP)
- iv. Blood smear examination malarial.
- v. Rapid diagnostic tests (pregnancy) and RDK for Pf malaria in endemic districts

- vi. Rapid tests for pregnancy.
- vii. RPR test for Syphilis/YAWS surveillance (endemic districts).
- viii. Rapid test kit for fecal contamination of water
- ix. Estimation of chlorine level of water using ortho-toluidine reagent

Mainstreaming of AYUSH

Essential:

- The AYUSH doctor at PHC shall attend patients for system specific AYUSH based preventive, promotive and curative health care and take up public health education activities including awareness generation about the uses of medicinal plants and local health practices.
- The signboard of the PHC should mention AYUSH facilities.

Desirable:

- Locally available medicinal herbs/plants should be grown around the PHC.

The manpower that should be available in the PHCs (IPHS 2010) is listed in **Table 28.4**.¹⁴

PHCs have been categorized into three types, one without 24 by 7 services, second with 24 by 7 nursing facilities and third with 24 by 7 emergency hospital care facilities and the IPHS are defined for each of them accordingly. The newly revised IPHS (PHC) has considered the services, infrastructure, manpower, equipments and drugs in two categories of Essential

TABLE 28.4: The manpower available in the CHCs (IPHS 2010)

Manpower*	Existing	Proposed
Medical officer	1	3 (At least 1 female)
AYUSH practitioner	0	1 (AYUSH/ISM system prevalent locally)
Account manager	0	1
Pharmacist	1	2
Nurse-midwife (Staff nurse)	1	5
Health workers (F)	1	1
Health Educator	1	1
Health Assistant (Male and Female)	2 (1 each)	2 (1 each)
Ophthalmic assistant	0	1
Multi-rehabilitation worker/Community based rehabilitation worker	0	1
Cold chain and vaccine logistic assistant	0	1
Data handler	0	1
Clerks	2	2
Laboratory technician	1	2
Driver	1	Optional/vehicles may be outsourced
Class IV	4	4
Total	15	28/29

*The standards prescribed in this document are for a PHC covering 20,000 to 30,000 populations with 6 beds.

(minimum assured services) and Desirable (the ideal level services which the states and UT shall try to achieve).

To ensure accountability, the Charter of Patients' Rights should be made available in each PHC. Every PHC should have a Rogi Kalyan Samiti/Primary Health Center's Management Committee for improvement of the management and service provision of the PHC.

COMMUNITY HEALTH CENTER LEVEL

The Community Health Centers (CHCs) which constitute the secondary level of health care were designed to provide referral as well as specialist health care to the rural population. CHCs constitute the First Referral Units (FRUs). 4 PHCs are included under each CHC thus catering to approximately 80,000 populations in tribal/hilly areas and 1,20,000 population for plain areas. CHC is a 30-bedded hospital providing specialist care in medicine, Obstetrics and Gynecology, Surgery and Pediatrics. There are 4276 CHCs functioning in the country as per Rural Health Statistics Bulletin published in July, 2009 (**Table 28.5**).^{15,16}

IPHS for Community Health Centers

In order to provide Quality Care in these CHCs Indian Public Health Standards (IPHS) are being prescribed.¹⁵

Service Delivery:

- All "Assured Services" as envisaged in the CHC should be available, which includes routine and emergency care in Surgery, Medicine, Obstetrics and Gynecology and Pediatrics in addition to all the National Health programmes.

TABLE 28.5: Medical Personnel associated manpower available in the CHCs (IPHS 2010)

Medical personnel	Existing	Proposed
Block health officer	*	*
General surgeon	1	1
Physician	1	1
Obstetrician and hynecologist	1	1
Pediatrician	1	1
Anesthetist	–	1
Public health manager	–	1
Eye surgeon	–	1 for every 5 CHCs **
Dental surgeon	–	1
General duty medical officer	1	6 (at least 2 female doctors)
Specialist of AYUSH	–	1
General duty medical Officer of AYUSH	–	1
Total	5	15/16

* Senior most specialists among the below mentioned specialists (Physician/General surgeon/Ped./Obs and Gyne/Anesthesia/Public Health/Ophthalmology). That person will be responsible for coordination of NHPs, management of ASHAs, Training and other responsibilities under NRHM apart from overall administration/Management of CHC, etc.

** 1 for every 5 CHCs as per Vision 2020 approved Plan of Action.

- Appropriate Guidelines for each National Programme for management of routine and emergency cases are being provided to the CHC.
- All the support services to fulfill the above objectives will be strengthened at the CHC level.

Service delivery in CHCs:

- OPD Services and IPD Services: General, Medicine, Surgery, Obs. and Gyne., Pediatrics and AYUSH, fixed day services by Ophthalmologist and Dentist (Essential) and daily basis (Desirable).
- Emergency Services
- Laboratory Services
- National Health Programmes

Support Manpower for CHCs

Personnel	Strength
Staff nurse	19
Public health nurse (PHN)	1
ANM	1
Pharmacist/compounder	3
Pharmacist—AYUSH	1
Laboratory Technician	3
Radiographer	2
Ophthalmic assistant	1
Dresser	2
Ward boys/Nursing orderly	5
Sweepers	5
Chowkidar	5
Dhobi	1
Mali	1
Aya	5
Peon	2
OPD attendant	1
Registration clerk	2
Statistical assistant/Data entry operator/Computer clerk	2
Accountant/Admin. Assistant	1
OT technician	1
Total	64

Standard treatment protocol for all national programmes and locally common diseases are made available at all CHCs. Standard Treatment protocol: is the “Heart” of quality and cost of care. All the efforts that are being made to improved “hardware, i.e. infrastructure” and “software, i.e. human resources” are necessary but NOT sufficient. These need to be guided by Standard Treatment Protocols.

Model Citizens Charter for CHCs

The Charter seeks to provide a framework which enables citizens to know about the services available, their quality and the means through which complaints regarding denial or poor qualities of services will be addressed.

Urban Primary Health Care

In order to improve the outreach of Primary Health Care, especially Family Planning and MCH services, in the urban slums or places inhabited by poor people, the Ministry of Health and Family Welfare set up a group under the chairmanship of Sh SV Krishnan, Additional Chief Secretary, Government of West Bengal in 1982.

The *Krishnan Committee* has given the recommendations for primary health care services in urban slums. The committee’s recommendations of 1982 have been implemented in some States. The Krishnan Committee recommendations pertain to areas where 40% or more population lives in slums or slum like conditions. Four types of health posts, depending upon the population of the area, are to be established under a scheme called the *urban revamping scheme*.

Reorganization of urban primary health care services to provide basic health and family welfare services to the population within 1 to 3 km of their dwellings and establishing appropriate linkages between primary, secondary and tertiary care centers in the area so that optimal utilization of the available health care facilities for referral services are ensured is one of the priority areas identified during the Ninth Five-year Plan. The Planning Commission has provided assistance to Governments of Delhi and Punjab to develop models for urban primary health care.

URBAN REVAMPING SCHEME

Health Posts

Urban revamping scheme was introduced in 1983 with a view to provide service delivery outreach, primary health care, family welfare and MCH services in urban areas. There are 871 health posts functioning in 10 States and 2 UTs. There are four types (A to D) of Health Posts sanctioned based on the population covered by each health post—Type A for areas with less than 5000 population, Type B for areas with 5,000 to 10,000 population, Type C for areas with population 10,000 to 250,00 and Type D for areas with population 250,00 to 50,000. If population of the area is more than 50,000 then it is to be divided into sectors of 50,000 population and a post is established at each sector. Central assistance is provided to pay salaries to staff posted at each post, to meet contingencies, if any and for rent for posts run by voluntary organizations, which are 50 in number.

Type-wise staff sanctioned is given below in **Table 28.6**.

The break up of 871 Health Posts functioning in the States and Union Territories based on Population covered by each health post is given in **Table 28.7**.

TABLE 28.6: Types of health parts

Name of the post	A	B	C	D
Lady doctor	—	—	—	1
Public health nurse	—	—	—	1
Nurse midwife	1	1	2	3-4
Male MPW*	—	1	2	3-4
Class IV	—	—	—	1
Computer-cum clerk	—	—	—	1
Voluntary woman health worker*	—	—	—	1

*At present, there is a ban on these categories of staff¹⁷

TABLE 28.7: Functioning of health parts in the states and union territories

Type of health post	No. of health posts
A	65
B	76
C	165
D	565

Ref:¹⁷

URBAN FAMILY WELFARE CENTRES

Urban Family Welfare Centres are on ground since First Five-year Plan to provide family welfare services in urban areas. Most of UFWCs are equipped to provide contraceptive supplies. At present 1083 centres are functioning. There are three types of Urban Family Welfare centres based on the population covered by each centre. The staffing pattern at each type of centre is given in **Table 28.8**.

National Health Programs

Some health problems are present on a large scale all over the country. In order to tackle them, not only huge expenditure but also elaborate planning and coordination are required. Hence they have to be organized at the Central or National level, though their implementation is done at the state level. These are, hence, called National Health Programs. Fourteen of these have been described in various chapters as indicated in **Table 28.9**.

The remaining three programs are described below:

Minimum needs program: This is not basically a national health program in the usual meaning of the term. However, it is described here because many of its components have a direct or indirect bearing on health. It was started in 1974 at the beginning of the Fifth Plan in order to fulfill certain basic needs and thereby raise the standard of living. It has the following components:

- Rural health
- Rural water supply
- Nutrition
- Elementary education
- Adult education
- Houses for landless laborers
- Environmental improvement of slums
- Rural electrification.

TABLE 28.8: Pattern of staff at each type of center

Type	Population covered	No of units	Staffing pattern
Type I	10000-25000	326	ANM-1, FP field worker-1
Type II	25000-50000	125	FP extension educator/LHV-1; FP field worker (Male)-1; ANM
Type III	Above 50000	632	Medical Officer-1 (Pref. Female) ANM-2, LHV-1, FP field worker (Male)—1, Storekeeper-cum-clerk—1

Source: Annual Report 1999-2000. Ministry of Health and Family Welfare, GOI¹⁷

TABLE 28.9: National health programs in various chapters

Program	Chapter
• National Tuberculosis Program	16
• Program for Control of Acute Respiratory Infections	16
• Guinea Worm Eradication Program	17
• Diarrheal Disease Control Program	17
• National Leprosy Eradication Program	18
• Sexually Transmitted Disease Control Program	18
• National AIDS Prevention and Control Program	18
• National Malaria Eradication Program (NMEP)	19
• National Filaria Control Program (NFCEP)	19
• Iodine Deficiency Disorders (IDD) Program	22
• National Nutrition Program	22
• Universal Immunization Program	30
• National Family Welfare Program	31
• School Health Program	32

Initially there were 8 components of the MNP. In the 6th Plan, adult education was added to MNP while in the 7th Plan, the following were also added to MNP.

- Rural domestic energy
- Rural sanitation
- Public distribution system.

A Chief Ministers Conference in 1996 decided that full coverage of the country by 7 basic services should be achieved by 2000 AD. These are:

- 100% coverage of provision of safe drinking water in rural and urban areas.
- 100% coverage of primary health service facilities in rural and urban areas.
- Universalization of primary education.
- Provision of public housing assistance to all shelterless poor families.
- Extension of mid-day meal program in primary schools to all rural blocks and urban slums and disadvantaged sections.
- Provision of connectivity to all unconnected villages and habitations.
- Streamlining of the Public Distribution System with focus upon the poor.

The Program of Nutritional Support to Primary Education popularly known as Mid-day Meal Program was launched in 1995 as a fully funded Centrally sponsored Scheme. All primary school children in Government and Government Aided schools are to be covered. Ideally a hot meal is provided to the children at school for 10 months in a year.

In the Ninth Plan the target is that 85% of village population should be connected with all weather roads. This is an extended target than the Eighth Plan where it was proposed that 85% villages should be connected.

It was decided in principal that the MNP should be introduced first in the remote, underserved areas and that all components of the package should be provided together in an area through intersectoral approach.

National water supply and sanitation program: It was started in 1954. It was supplemented in 1972 by another special program called the Accelerated Rural Water Supply Program. During the fifth plan, rural water supply was included in the Minimum Needs Program of various state plans. The Government launched in 1981 the International Drinking Water Supply and Sanitation Decade. The criteria of a **problem village** were laid down as follows:

- No source of safe water within 1.6 km radius
- Water level more than 15 meter deep
- Excess level of iron, fluoride, salinity or other toxic elements in water
- Water source exposed to risk of cholera.

The existing norm for rural water supply is 40 liters of drinking water per capita per day and a public standpost or a hand-pump for 250 persons in addition to the other criteria. By 1997, there were 61,724 habitations without any safe source of drinking water, while 3.78 lakh habitations were partially covered and 1.51 lakh habitations had quality problems like excess fluoride, salinity, iron and arsenic, etc.¹⁸

The National Drinking Water Mission has been re-named as the Rajiv Gandhi National Drinking Water Mission.¹⁹

National Program for Control of Blindness: It was sanctioned in November 1976 and incorporates the earlier National Trachoma Control Program started in 1963. Its ultimate goal was to reduce the prevalence of blindness from 1.4% in 1987-88 to 0.3% by 2000 AD. It aims at providing comprehensive eye care through the primary health care system.

OBJECTIVES

- Intensification of educational activities through use of all available channels.
- Augmenting ophthalmic services at the periphery for restoring sight and relieving eye problems by adopting an eye camp approach.
- Establishing permanent facilities for eye care as an integral part of general health services at peripheral, intermediate and central levels.
- Orientation of paramedical personnel, teachers, social workers and community leaders on the problem of visual impairment.

ACTIVITIES

The program is a 100% centrally sponsored scheme. For catering to population residing in peripheral and remote areas, mobile units are used. There are 80 central mobile units and 301 district mobile units functioning. Each Central Mobile Unit provides camp services in 5 adjoining districts.

A new category of technical personnel. Ophthalmic assistants, was created. Ophthalmic assistants are attached to PHC/Mobile Units and at district hospital. In addition, refractionists and orthoptists have also been trained. The ophthalmic assistants are trained at 39 designated schools. They help in training other PHC staff, testing vision and providing community eye health education. They also participate in survey work.

At the district level, augmentation of ophthalmic and support manpower has been planned. At state level, a state eye hospital is being strengthened. In medical colleges, the eye departments are to be gradually upgraded, providing 75 eye beds.

11 Regional Institutes of Ophthalmology, in addition to the National Institute of Ophthalmology (Dr RP Center), have been set up as specialized centers with basic laboratory support and a community ophthalmology wing.⁸

Nongovernmental organizations play an important role in the program and they are provided financial assistance for organizing eye camps. The program also envisages setting up eye collection centers for corneal grafting and augmenting ophthalmic medical manpower by increasing postgraduate facilities.

At PHC level, facilities exist for treatment of simple eye diseases, diagnosis and referral of cases needing treatment at intermediate and tertiary level eye care units, health education, survey of the local community and screening of school children and local industrial workers.

ACHIEVEMENTS (TABLE 28.10)

The achievements under the NPCB are as follows.⁸

TABLE 28.10: Achievements under NPCB

S.No.	Parameter	Achievement
1.	Central mobile units	80
2.	District mobile units	301
3.	State ophthalmic cells established	18
4.	Eye banks established	166
5.	District hospitals strengthened	423
6.	Medical colleges augmented	82
7.	Regional institutes established	11
8.	PHC's strengthened	5441
9.	Ophthalmic assistant training schools established	39
10.	District blindness control	482

Universal Precautions

The universal precautions should be practiced by all medical and paramedical workers involved in providing health services.¹¹ The basic components include:

- i. Hand washing thoroughly with soap under running water
 - Before carrying out the procedure
 - Immediately if gloves are torn and hand is contaminated with blood or other body fluids
 - Soon after the procedure, with gloves on and again after removing the gloves
- ii. Barrier precautions: Using protective gloves, mask, waterproof aprons and gowns.
- iii. Strict asepsis during the operative procedure and cleaning the operative site. Practice the “no touch technique” which is: any instrument or part of instrument which is to be inserted in the cervical canal must not touch any nonsterile object / surface prior to insertion.
- iv. Decontamination and cleaning of all instruments immediately after each use.
- v. Sterilization/high level disinfection of instruments with meticulous attention.
 - Instruments and gloves must be autoclaved
 - In case autoclaving is not possible, the instruments must be fully immersed in water in a covered container and boiled for at least 20 minutes.
- vi. Appropriate waste disposal.

HEALTH FOR ALL IN 21ST CENTURY

In May 1998, the World Health Organization adopted a resolution in support of the new global Health for All policy. The new policy, Health for All in the 21st Century, succeeds the Health for All by the Year 2000 strategy launched in 1977. In the new policy, the worldwide call for social justice is elaborated in key values, goals, objectives, and targets. The 10 global health targets are the most concrete end points to be pursued. They can be divided into three subgroups—four health outcome targets, two targets on determinants of health, and four targets on health policies and sustainable health systems. All member states are supposed to set their own targets within this framework, based on their specific needs and priorities.²⁰

There are two main aims behind the Health for All in the 21st Century program. Firstly, the WHO wants to develop a shared vision by listing the 10 most important health issues. Secondly, the organization wants to formulate 10 targets to motivate all member states to take action and to set priorities for resource allocation. To fulfill these aims the WHO sought to include in the new targets components that were inspirational and achievable.

It is proposed that countries should be categorized in the following manner with regard to the targets:

- Countries that have already achieved this target
- Countries for which the global target is achievable and challenging
- Countries that find the global target hard to achieve and therefore “demotivating”.

The first group needs stricter target levels, and the third group less stringent ones. If a breakdown of this kind is made for each target, some countries may be classified in different groups for different targets. In this way, the targets will provide an insight into the health status of the population and could be useful for policy makers in member states in encouraging action and allocating their resources.

GLOBAL HEALTH TARGETS²⁰

Health Outcome

Health equity: childhood stunting: By 2005, health equity indices will be used within and between countries as a basis for promoting and monitoring equity in health. Initially, equity will be assessed on the basis of a measure of child growth.

Survival: maternal mortality rates, child mortality rates, life expectancy: By 2020, the targets agreed at world conferences for maternal mortality rates (< 100/1,00,000 live births), under 5 years or child mortality rates (< 45/1000 live births), and life expectancy (> 70 years) will be met.

Reverse global trends of five major pandemics: By 2020, the worldwide burden of disease will be reduced substantially. This will be achieved by implementing sound disease control programs aimed at reversing the current trends of increasing incidence and disability caused by tuberculosis, HIV/AIDS, malaria, diseases related to tobacco, and violence or trauma.

Eradicate and eliminate certain diseases: Measles will be eradicated by 2020. Lymphatic filariasis will be eliminated by the year 2020. The transmission of Chagas’ disease will be interrupted by 2010. Leprosy will be eliminated by 2010, and trachoma will be eliminated by 2020. In addition, vitamin A and iodine deficiencies will be eliminated before 2020.

Determinants of Health

Improve access to water, sanitation, food, and shelter: By 2020, all countries, through intersectoral action, will have made major progress in making available safe drinking water, adequate sanitation, and food and shelter in sufficient quantity and quality, and in managing risks to health from major environmental determinants, including chemical, biological, and physical agents.

Measures to promote help: By 2020, all countries will have introduced, and be actively managing and monitoring, strategies that strengthen health enhancing lifestyles and weaken health damaging ones through a combination of regulatory, economic, educational, organizational, and community based programs.

Health Policies and Sustainable Health Systems

Develop, implement, and monitor national health for all policies: By 2005, all member states will have operational mechanisms for developing, implementing, and monitoring policies that are consistent with this Health for All policies.

Improve access to comprehensive essential health care: By 2010, all people will have access throughout their lives to comprehensive, essential, quality health care, supported by essential public health functions.

Implement global and national health information and surveillance systems: By 2010, appropriate global and national health information, surveillance, and alert systems will be established.

Support research for health: By 2010, research policies and institutional mechanisms will be operational at global, regional, and country levels.

Appendix

RECOMMENDATIONS OF ALMA ATA CONFERENCE²¹

Inter-relationship between health and development: The conference, recognizing that health is dependent on social and economic development, and also contributes to it, recommends that governments incorporate and strengthen primary health care within their national development plans, with special emphasis on rural and urban development programs and coordination of health-related activities of different sectors.

Community participation in primary health care: The Conference, considering that national and community self-reliance and social awareness are among the key factors in human development, and acknowledging that people have the right and duty to participate in the process for the improvement and maintenance of their health, recommends that governments encourage and ensure full community participation through the effective propagation of relevant information, increased literacy, and the development of the necessary institutional arrangements through which individuals, families, and communities can assume responsibility for their health and well-being.

The role of national administrations in primary health care: The Conference, noting the importance of appropriate administrative and financial support at all levels, for coordinated national development, including primary health care, and for translating national policies into practice, recommends that governments strengthen the support of their general administration to primary health care and related activities through coordination among different ministries and the delegation of appropriate responsibility and authority to intermediate and community levels, with the provisions of sufficient manpower and resources to these levels.

Coordination of health and health-related sectors: The Conference, recognizing that significant improvement in the health of all people requires the planned and effective coordination of national health services and health-related activities of other sectors, recommends that national health policies and plans take full account of the inputs of other sectors bearing on health; that specific and workable arrangements be made at all levels in particular at the intermediate and community levels for the coordination of health services with all other activities contributing to health promotion and primary health care; and that arrangements for coordination take into account the role of the sectors dealing with administration and finance.

Content of primary health care: The Conference, stressing that primary health care should focus on the main health problems in the community, but recognizing that these problems and the ways of solving them will vary from one country and community to another, recommends that primary health care should include at least: education concerning prevailing health problems and the methods of identifying, preventing, and controlling them; promotion of food supply and proper nutrition, an adequate supply of safe water, and basic sanitation; maternal and child health care, including family planning; immunization against the major infectious diseases; prevention and control of locally endemic diseases; appropriate treatment of common diseases and injuries; promotion of mental health; and provision of essential drugs.

Comprehensive primary health care at the local level: The Conference, confirming that primary health care includes all activities that contribute to health at the interface between the community and the health system, recommends that, in order for primary health care to be comprehensive, all development-oriented activities should be interrelated and balanced so as to focus on problems of the highest priority as mutually perceived by the community and the health system, and that culturally acceptable, technically appropriate,

manageable, and appropriately selected interventions should be implemented in combinations that meet local needs. This implies that single-purpose programs should be integrated into primary health care activities as quickly and smoothly as possible.

Support of primary health care within the national health system: The Conference, considering that primary health care is the foundation of a comprehensive national health system and that the health system must be organized to support primary health care and make it effective, recommends that Governments promote primary health care and related development activities so as to enhance the capacity and determination of the people to solve their own problems. This requires a close relationship between the primary health care workers and the community, each team being responsible for a defined area. It also necessitates reorienting the existing system to ensure that all levels of the health system support primary health care by facilitating referral of patients and consultation on health problems; by providing supportive supervision and guidance, logistic support, and supplies; and through improved use of referral hospitals.

Special needs of vulnerable and high-risk groups: The Conference, recognizing the special needs of those who are least able, for geographical, political, social or financial reasons, to take the initiative in seeking health care, and expressing great concern for those who are the most vulnerable or at greatest risk, recommends that, as part of total coverage of populations through primary health care, high priority be given to the special needs of women, children, working populations at high risk, and the underprivileged segments of society, and that the necessary activities be maintained, reaching out into all homes and working places to identify systematically those at highest risk, to provide continuing care to them, and to eliminate factors contributing to ill health.

Roles and categories of health and health-related manpower for primary health care: The Conference, recognizing that the development of primary health care depends on the attitudes and capabilities of all health workers and also on a health system that is designed to support and complement the frontline workers, recommends that governments give high priority to the full utilization of human resources by defining the technical role, supportive skills, and attitudes required for each category of health worker according to the functions that need to be carried out to ensure effective primary health care, and by developing teams composed of community health workers, other developmental workers, intermediate personnel, nurses, midwives, physicians, and where applicable, traditional practitioners and traditional birth attendants.

Training of health and health-related manpower for primary health care: The Conference, recognizing the need for sufficient numbers of trained personnel for the support and delivery of primary health care, recommends that Government undertake or support reorientation and training for all levels of existing personnel and revised programs for the training of new community health personnel; that health workers, especially physicians and nurses, should be socially and technically trained and motivated to serve the community; that all training should include field activities; that physicians and other professional health workers should be urged to work in underserved areas early in their career; and that due attention should be paid to continuing education, supportive supervision, the preparation of teachers of health workers, and health training for workers from other sectors.

Incentives for service in remote and neglected areas: The Conference, recognizing that service in primary health care focused on the needs of the underserved requires special dedication and motivation, but that even then there is a crucial need to provide culturally suitable rewards and recognition for service under difficult and rigorous conditions, recommends that all levels of health personnel be provided with incentives scaled to the relative isolation and difficulty of the conditions under which they live and work. These incentives should be adapted to local situations and may take such forms as better living and working conditions and opportunities for further training and continuing education.

Appropriate technology for health: The Conference, recognizing that primary health care requires the identification, development, adaptation, and implementation of appropriate technology, recommends that governments, research and academic institutions, nongovernmental organizations, and, especially, communities, develop technologies and methods that: contribute to health, both in the health system and in associated services; are scientifically sound, adapted to local needs, and acceptable to the community; and are maintained by the people themselves, in keeping with the principle of self-reliance, with resources the community and the country can afford.

Logistic support and facilities for primary health care: The Conference, aware that the success of primary health care depends on adequate, appropriate, and sustained logistic support in thousands of communities in many countries, raising new problems of great magnitude, recommends that governments ensure that efficient administrative, delivery, and maintenance services be established, reaching out to all primary health care activities at the community level; that suitable and sufficient supplies and equipment be always available at all levels in the health system, in

particular to community health workers; that careful attention be paid to the safe delivery and storage of perishable supplies such as vaccines; that there be appropriate strengthening of support facilities including hospitals, and that Governments ensure that transport and all physical facilities for primary health care be functionally efficient and appropriate to the social and economic environment.

Essential drugs for primary health care: The Conference, recognizing that primary health care requires a continuous supply of essential drugs; that the provision of drugs accounts for a significant proportion of expenditures in the health sector; and that the progressive extension of primary health care to ensure eventual national coverage entails a large increase in the provision of drugs, recommends that governments formulate national policies and regulations with respect to the import, local production, sale and distribution of drugs and biologicals so as to ensure that essential drugs are available at the various levels of primary health care at the lowest feasible cost; that specific measures be taken to prevent the overutilization of medicines; that proved traditional remedies be incorporated; and that effective administrative and supply systems be established.

Administration and management for primary health care: The Conference, considering that the translation of primary health care into practice requires the strengthening of the administrative structure and managerial processes, recommends that governments should develop the administrative framework and apply at all levels appropriate managerial processes to plan for and implement primary health care, improve the allocation and distribution of resources, monitor and evaluate programs with the help of a simple and relevant information system, share control with the community, and provide appropriate management training of health workers of different categories.

Health services research and operational studies: The Conference, emphasizing that enough is known about primary health for governments to initiate or expand its implementation, but also recognizing that many long-range and complex issues need to be resolved, that the contribution of traditional systems of medicine calls for further research, and that new problems are constantly emerging as implementation proceeds, recommends that every national program should set aside a percentage of its funds for continuing health services research; organize health services research and development units and field areas that operate in parallel with the general implementation process; encourage evaluation and feedback for early identification of problems; give responsibility to educational and research institutions and thus bring them into close collaboration with the health system; encourage the involvement of field workers and community members; and undertake

a sustained effort to train research workers in order to promote national self-reliance.

Resources for primary health care: The Conference, recognizing that the implementation of primary health care requires the effective mobilization of resources bearing on health, recommends that, as an expression of their political determination to promote the primary health care approach, governments, in progressively increasing the funds allocated for health, should give first priority to the extension of primary health care to underserved communities; encourage and support various ways of financing primary health care, including, where appropriate, such means as social insurance, cooperatives, and all available resources at the local level, through the active involvement and participation of communities; and take measures to maximize the efficiency and effectiveness of health-related activities in all sectors.

National commitment to primary health care: The Conference, affirming that primary health care requires strong and continued political commitment at all levels of government, based upon the full understanding and support of the people, recommends that governments express their political will to attain health for all by making a continuing commitment to implement primary health care as an integral part of the national health system within overall socioeconomic development, with the involvement of all sectors concerned; to adopt enabling legislation where necessary; and to stimulate, mobilize, and sustain public interest and participation in the development of primary health care.

National strategies for primary health care: The Conference, stressing the need for national strategies to translate policies for primary health care into action, recommends that governments elaborate without delay national strategies with well-defined goals and develop and implement plans of action to ensure that primary health care be made accessible to the entire population, the highest priority being given to underserved areas and groups, and reassess these policies, strategies, and plans for primary health care, in order to ensure their adaptation to evolving stages of development.

Technical cooperation in primary health care: The Conference, recognizing that all countries can learn from each other in matters of health and development, recommends that countries share and exchange information, experience, and expertise in the development of primary health care as part of technical cooperation among countries, particularly among developing countries.

International support for primary health care: The Conference, realizing that in order to promote and sustain health care and overcome obstacles to its implementation, there is a need for strong, coordinated, international solidarity and support, and welcoming the

offers of collaboration from United Nations Organizations as well as from other sources of cooperation, recommends that international organizations, multilateral and bilateral agencies, nongovernmental organizations, funding agencies, and other partners in international health acting in a coordinated manner should encourage and support national commitment to primary health care and should channel increased technical and financial support into it, with full respect for the coordination of these resources by the countries themselves in a spirit of self-reliance and self-determination, as well as with the maximum utilization of locally available resources.

Role of WHO and UNICEF in supporting primary health care: The Conference, recognizing the need for a world plan of action for primary health care as a cooperative effort of all countries, recommends that WHO and UNICEF, guided by the declaration of Alma Ata and the recommendations of this Conference, should continue to encourage and support national strategies and plans for primary health care as part of overall development. Recommends that WHO and UNICEF, on the basis of national strategies and plans, formulate as soon as possible concerted plans of action at the regional and global levels that promote and facilitate the mutual support of countries, particularly through the use of their national institutions, for accelerated development of primary health care, and further recommends that WHO and UNICEF continuously promote the mobilization of other international resources for primary health care.

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Information, Education, Communication and Training in Health

Preservation of good health depends upon adopting good health practices and avoiding practices that are harmful to health. Out of the practices prevalent in a community, some are conducive to good health, some to bad health and some are inconsequential to health. The aim of health education is to bring about a change in health behavior of the people in such a manner that the harmful health practices are given up while the good ones are reinforced. Such change cannot come about simply because people are ordered to do so by the authorities, exhorted to do so by leaders and politicians, advised to do so by health professionals or rewarded for doing so by the government or nongovernment organizations. People, whether literate or illiterate, do not change their behavior unless they understand and feel the need for the same. To accomplish this is the task for health education.

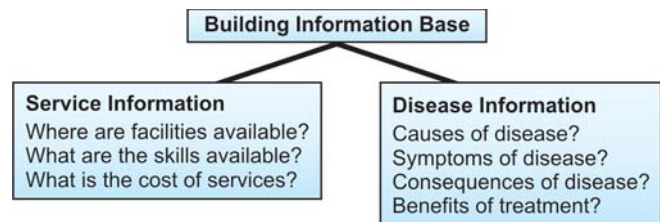
The importance of health education has been increasingly realized during the last three decades, so much so that health education has now emerged as a speciality in itself. The reason why so much attention is being focussed on health education lies in the realization that health care delivery systems, though elaborately planned and provided, remain ineffective if unsupported by health education aimed at motivating people to use these services and cooperate with the concerned health programs. The importance of health education has been strongly highlighted by the Alma Ata conference. The conference pointed out that community participation is crucial to ensure optimum utilization of the services provided by a health care delivery system. It is stressed that health is an individual responsibility and that it must be ensured that every individual is health conscious, so that he may observe healthy living practices and seek appropriate medical help at appropriate time.

Definitions and Concepts

Information

One of the most common ways to define information is to describe it as one or more statements or facts that are received by a human which have some form of

worth to him. Information affects the perspective of the recipient person. The facts and figures that are received by humans have to be true and factual to be labeled as information. Lies, falsehood or counterfactual 'information' is not information itself but is called 'misinformation'. Information is therefore that 'intangible' news and facts, which an individual uses to bridge discontinuities and gaps that are prevalent in his mind. It is therefore a process of creating meaning from things that are seen or perceived by an individual.



Education

It is the process by which behavioral change takes place in an individual as a result of experience which he has undergone.¹ Education is a learning process or a series of learning experiences through which an individual informs and orients himself to develop skills and intelligent action.²

Webster defines, Education as the process of educating or being educated; the knowledge or skill developed by a learning process; a program of instruction and an instructive or enlightening experience.

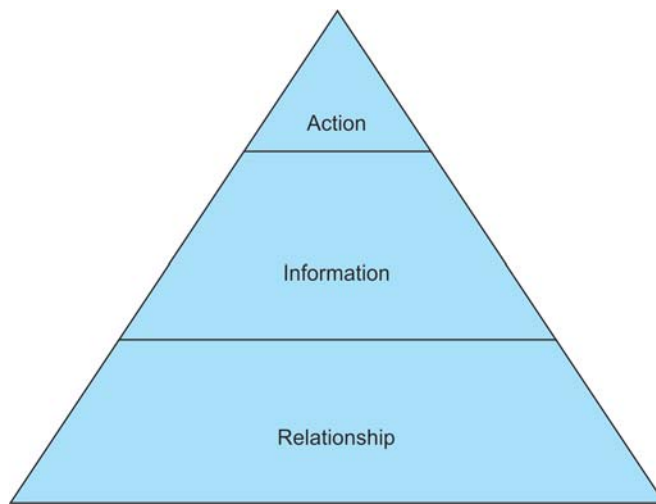
Communication

Communication is the process of attempting to change the behavior of others. The communicator's job is chiefly helping people learn to look at things in a new way by sharing ideas and information. When people exchange ideas and information, they can work together better. Sharing entails parting with information that gives power. Health secrets are the most closely guarded secrets of the medical profession. Sharing this knowledge helps overcome the imbalance in the power of society over its health and promotes self-reliance.^{2a}

Communication is a general term for the flow of information linking people or places. It is therefore the

process of exchanging news, facts, opinions and messages between individuals.

In communication, initially rapport or relationship is built up. Then information is provided and the final step is to promote ideas into action.



Health

It is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1948).

The very definition of health encompasses the essence of health education by making the individuals and communities equal partners in the process of ensuring freedom from sickness and attaining the highest plane of physical, mental and social health. Spreading the word that what people should do to remain healthy is important, but this is not sufficient to ensure health. In many situations, it is not only the individual who needs to change because there are other things that influence the way people behave and react. The physical surroundings, people with whom they live and interact, the work they do and the resources available to them must all be taken into consideration for improving health.

HEALTH EDUCATION

- Definition adopted by WHO: “Health education, like general education, is concerned with changes in knowledge, feelings and behavior of people. In its most usual forms, it concentrates on developing such health practices as are believed to bring about the best possible state of well-being”.³
- Definition adopted by the National Conference on Preventive Medicine in USA: “Health education is a process that informs, motivates and helps people to adopt and maintain healthy practices and lifestyles, advocates environmental changes as needed to

facilitate this goal and conducts professional training and research to the same end.⁴

- Health education is the education for identifying health needs and matching them with suitable behavior.⁵ The entire process of involving people in learning about health and disease and aiding them to act suitably for overcoming illness and preserving a positive health is health education.³
- Health education is that part of health care that is concerned with promoting healthy behavior. Through health education we make people understand their behavior and how it affects health. We do not force people to change—Rather, we encourage them to make their own choices for a healthy life. Health education is also needed to promote the proper use of health services.
- Health education is any combination of learning experiences designed to facilitate voluntary actions conducive to health (Green and Kreuter, 1991).
- Health education is a practical endeavor focused on improved understanding about the determinants of health and illness and helping people develop the skills they need to bring about change (French, 1990).
- It is the process that assists individuals, small groups and larger populations to identify their health needs and priorities, obtain information and resources to meet those needs and mobilize action aimed at achieving desired change. It focuses on creating an environment in which there are strong individual and structural supports for informed and voluntary decision making about personal health and community well-being (Berkeley School of Public Health, University of California).
- It is the combination of planned social actions and learning experiences designed to enable people gain control over the determinants of health and health behaviors, and the conditions that affect their health status and the health status of others (XIV World Health Conference on Health Education, WHO, IUHE).

All definitions of health education emphasize the central role of an individual and the community in bringing about the desirable change.

Health education is not the same as health information. Correct information is certainly a basic part of health education but health education must also address the other factors that affect health behavior such as the availability of resources, effectiveness of community leadership, social support from family members and the levels of self-help groups. Health education is therefore incomplete unless it encourages involvement and choice by the people themselves.^{5a}

HEALTH PROMOTION

Health promotion is the combination of educational and environmental supports for actions and conditions of

living conducive to health (Green and Kreuter, 1991). The 'educational component' of health promotion provides individuals with the knowledge, skills and critical awareness that enable them to make voluntary and informed choices concerning personal or social changes to enhance their health. The 'environmental' component of health promotion refers to the social, political, economic, organizational, policy and regulatory circumstances having a bearing on health related behavior or more directly on health itself.

Health promotion therefore is a planned combination of health education, preventive measures and policy changes aimed at improving health status and creating healthy environments and behaviors. Health promotion provides knowledge, skills and capacity to assist individuals, groups and communities in identifying health needs, obtaining information and resources and mobilizing them to achieve change (Office of Health Promotion, Washington State Department of Health).

Health promotion can also be defined as the science and art of helping people change their lifestyle to move towards a state of optimal health, which can be defined as a balance of physical, emotional, social, spiritual and intellectual health. Lifestyle change can be facilitated through a combination of efforts to enhance awareness, change behavior and create environments that support good health practices. Of all these, three supportive environments will probably have the greatest impact in producing lasting changes.

The WHO has utilized the broad definition of health to develop the concept of health promotion as the process of enabling people to increase control over and to improve their health.

Increasingly health promotion is being recognized as an essential element of health development. During the 1970's there was a growing concern about the direction of the health system. Despite a rapid growth in international health gains, there were still some groups of people who had not experienced any improvement in their health status. More and more high technology developments took place in medicine but there were some people who could not access even the most basic health care. This concern resulted in reorientation of health systems towards primary health care of which health promotion was an integral part.

PRINCIPLES OF HEALTH PROMOTION

- Health promotion involves the population as a whole in the context of everyday life, rather than focusing on people at risk for specific diseases.
- Health promotion is directed towards action on the determinants or causes of health.
- Health promotion combines diverse but complementary methods or approaches.
- Health promotion aims particularly at effective and concrete public participation.

LEARNING

It is the process of acquiring knowledge, attitudes or skills. Sometimes it may be merely passive or incidental, especially in relation to knowledge. For example, an individual may read from a cigarette pack or a hoarding that smoking is injurious to health. This may be merely passive, incidental, cognitive learning, without attitudinal or behavioral change. He may as well continue to smoke throughout his life. In its fullest sense, learning is complete when behavior changes. As a matter of fact, learning, teaching, education and training can be really said to have occurred only when behavior changes.

PERCEPTION

It is the act or faculty of receiving sensations and giving them a meaning in the intellect. Perception may be subjective or objective. Subjective perception may sometimes be faulty. Since perception is a component of knowledge, knowledge itself may or may not be correct, depending upon whether the perception is correct.

KNOWLEDGE

It is the collection and storage of information or experience (i.e. knowledge = perception + storage of information in the brain).

Knowledge is not the same as information. It is the sense that people make of information. Thus people create their own meaning, i.e. their own knowledge out of the information they receive, according to their own circumstances, their use for that information and their own prior knowledge. Only when information enables people to communicate, participate and make informed choices does information become knowledge. Knowledge often comes from experience.

ATTITUDE

An attitude is a predisposition to act in a certain way in response to a given stimulus. It has been defined as "a relatively enduring organization of beliefs around an object or situation, predisposing one to respond in some preferential manner. In simple words, the combination of knowing about a thing and forming a tendency to react is the attitude of a person (Attitude = knowledge + feeling). It may be mentioned that some times we may form attitudes even without knowing about a thing. For purpose of understanding, attitude may also be described as a "State of readiness" of the individual to deal with an object or type of objects. Attitude has three components: a cognitive component (knowing about something), a feeling about it and a tendency to take action.

MOTIVATION

It has been defined by Lindsay as “a combination of forces which initiate, direct and sustain behaviours toward a goal.”⁵

DECISION

It is the commitment to carry out a specific task or to adhere to a particular course of action in the future.

BEHAVIOR

It refers to the “voluntary movements and purposive acts arising out of decisions taken by the individual.”

Behavior is usually purposive. The purpose may be of two types:

- Fulfilling a need or a want
- Being accepted in the group or society to which the person belongs.

Behavior is sometimes classified as covert and overt.

Overt behavior is an action outwardly done by the individual and is visible as such.

Covert behavior is a strong attitude which is most likely to give rise to a particular action. In other words, covert behavior is strong attitude.

In all communities there are already many kinds of behavior that promote health, prevent illness and help in the cure and rehabilitation of sick people. These kinds of behavior should be identified and encouraged. Our behavior changes all the time because of natural events. When changes take place in the community around us, we often change ourselves without thinking much about it. This is a natural change. Sometimes we make plans to improve our health. This is planned behavior change. In fact, it is well known that most unhealthy behaviors are weeded out by people because of their bad experiences with such behavior. However there is always a segment which is not able to change harmful behavior because of some specific personal characteristics. The health education and promotion process should identify such characteristics of people and concentrate on the difficulties such people have in changing behavior.

Counseling

Counseling is face to face communication through which a person is helped to make a decision or solve a problem. Here, choice is given to the clients from where the client himself makes his decision. There are many areas of counseling in health care, e.g. family planning, genetic counseling, etc. But in advising, the client is directly asked to carry out the order as advised.

Core issues between the client and counselor

- i. Every client has the right to be informed
- ii. Counselor must respect the confidentiality and privacy of the client
- iii. Counselor should be objective and nonjudgmental
- iv. Client has the right to withdraw from the counseling at any point to time

Elements of counseling (GATHER approach)

- G — Greet the client (make them comfortable, give attention)
- A — Ask/ascertain needs/problems or reasons for coming
- T — Tell client about merits, demerits, logistics and costs of different methods or options
- H — Help client to make voluntary decisions
- E — Explain and educate about the chosen decision/action/method
- R — Return for follow-up visit.

PROPAGANDA

Propaganda is merely a publicity campaign aimed at presenting a particular thing or concept in a favorable light in such a way that public may accept it without thinking about it analytically. Health education, by contrast, promotes active thinking and assessment of the problem by the people and encourages them to decide for themselves whether they want to change and in what manner.

Role and Need of Health Education and Promotion

Man has a right to correct information. If such information is not provided, the consequences can be dangerous. Education means translation of knowledge into practice by influencing the beliefs, attitudes, habits and practices; in simpler words, it means practical training. Education helps in moulding a person for a particular purpose about which knowledge has been imparted. Health education would thus mean putting health knowledge into practice, i.e. training of an individual, group or community in the ways of healthy living. Health education concerns all experiences of an individual, group, or community that influence beliefs, attitudes, and behavior with respect to health, as well as the processes and efforts of producing change when this is necessary for optimum health. This all inclusive concept of health education recognizes that many experiences, both positive and negative, have an impact on what an individual, group, or community thinks or feels, and does not restrict health education to those situations in which planned or formal health activities take place.

It has been well realized that mere spreading of health information or knowledge does not produce by itself a lasting effect on health behaviors of the people. Lessons imparted through lectures and talks are forgotten too soon. On the other hand, activities in which people themselves participate are more enduring as means of education. This has been beautifully expressed in the following Chinese aphorism.

“If I hear it I forget it;

If I see it I remember it;

If I do it I know it.”

Thus, to train the people in healthy living or to impart health education, one has to motivate them to do things conducive to health or to adopt health practices. Health education is a translation of what is known about health into desirable individual and community behavior patterns by means of an education process.

Health education, properly carried out, forms one of the most effective tools in preventive medicine. It forms the basis for potential success of various health programs aimed at family planning, malaria eradication, tuberculosis control, clean water supply, disposal of wastes, early diagnosis of cancer, etc. It is a bridge between the people needing services and the institutions providing the same. This bridge is the major approach to obtain people participation in any health program. Public health workers must realize that they have to work with the people and not in a vacuum. No program can be a success without people's participation.

People in villages are generally poor and uneducated. They are not only ignorant of healthy practices but are often apathetic towards them. The messages coming from the experts, who are often out of contact with the people, may be understood easily by educated persons with a technical background but not necessarily by the illiterate laymen for whom they are really meant. If a health agency has not succeeded in implementation of a public health program, a likely reason is that the program has not adjusted to the felt needs of the people and has not procured their participation.

A recent example is that of Buddha Gaya Gama, a 100-house model village established in Bihar with Sri Lankan initiative and aid. The two-room concrete houses with attached indoor flush toilet, given to the people have not found favor with them. After six months the houses were built, the toilets remain unused and the housewives cook in the open in preference to indoor kitchen.^{5b} This situation could have been avoided if the funds were spent to fulfill the felt needs of the people. Alternatively, if the aim was that people should use flush latrines, then it would have been preferable to educate and motivate them, so that they demand latrines on their own and use them when they have them. Another example is from Liberia, where the government launched a program for drilling of wells to

make available fresh drinking water. However, many people preferred to use muddy polluted water, perceiving the clean, fresh water as “too thin.”^{5c} This situation could have been avoided if the well-drilling program had an inbuilt component of appropriate health education.^{5b}

Objectives of Health Education and Promotion

It may be recalled that according to the definition adopted by the National Conference on Preventive Medicine,⁴ “*health education is a process that informs, motivates and helps people to adopt and maintain healthy practices and lifestyles.*” The three objectives of health education directly flow from this definition and are described below.⁶

Informing People

Information is a basic right. It is also a prerequisite to proper awareness and assessment of one's duties and rights. Health is basic right of all human beings and health information is necessarily so. Only an informed community will aspire, work, demand and fight for its right, i.e. health. Dissemination of information is certainly easier when people are literate. However, education is not literacy and people can still be given adequate information in a community where the majority of people are still illiterate.⁷ Health information helps people in becoming aware of their health problems, in developing proper perceptions about them and in seeking appropriate solutions for the same.

Motivating People

Mere information is not sufficient. The knowledge that tobacco and alcohol are harmful to health does not, in itself, ensure that people will give them up. After information it is necessary to achieve the second objective, i.e. motivation of the people to adopt a certain behavior. This motivation must be developed in them by a process of change of behaviors, as described later. For example, before people voluntarily practice family planning, they must be motivated or mentally prepared and willing to adopt the small family norm.

Guiding into Action

Motivation by itself does not automatically lead to actual practice or behavior. Along with motivation to drive a car, a person must have help and guidance from an instructor before he can drive freely. Many smokers, alcoholics and heroin addicts are motivated to give up their habits, but need appropriate guidance. Young mothers may be motivated to breastfeed their babies, but may need guidance and support.

The Process of Change in Behavior

Information, motivation and guidance, the three objectives of health education described above are, in fact, the components of the process of change in behavior. The process of change must be well understood by an educator in order to succeed in his mission. Behavior refers to purposive acts arising out of decisions taken by the individual. It is obvious that doing something under force is not behavior. Behavior is always voluntary. Hence health behavior of a person can change only when he decides to change it.

A *decision* is a commitment to perform a task or to adhere to a course of action in future. Psychologists have identified *three stages* in the *decision making* process:

1. A *predecisional phase* in which the individual assesses and compares the pros and cons of the recommended behavior.
2. A *decisional phase*, in which the individual decides that the particular course of action is not only advantageous to him but is also an immediate must.
3. A *postdecisional phase*, in which the person, having decided to follow a course of action and having acted initially, judges the pros and cons again in the light of the experience gained. The unfavorable and unpleasant component of the experience gives rise to a *postdecisional conflict* in his mind, which is resolved either by reversing the decision (i.e. giving-up the new behavior), or by making suitable mental adjustment to reconcile with the situation.

What is implied in the third objective (guiding into action) mentioned in the previous section is that the health educator guides and helps the client to stick to the new behavior by encouraging him to adjust to the new situation.

Decision is an implicit component of motivation or the process of adoption. One cannot be motivated to do something unless one has decided to do it. Motivation initiates, directs and sustains behavior towards a goal. Thus, there are *three stages in the process of motivation*.

1. In the first stage of 'initiation', the mind starts thinking whether the proposed change of behavior is of ultimate utility.
2. In the second stage of 'direction', the behavior is directed towards attainment of the goal. The individual is aware that a solution exists and he is prepared to put that solution into practice.
3. In the third *stage of sustained behavior*, the individual has tried the new behavior or practice and is convinced of its benefit and the desirability of continuing it in future.

It is axiomatic that motivation for undertaking an activity can occur only when the individual feels the need for something, i.e. when he is not fully satisfied with the present situation. In other words, the individual must have wants, desires, urges or needs, to fulfil which he

is motivated to perform an activity, i.e. to adopt a certain behavior pattern. Once the behavioral activity is performed, the tension is relieved and the person becomes quiet once more. This **satisfaction-tension-motivated tension-satisfaction cycle** is explained in **Figure 29.1**. It is clear that in order to change behavior, the health educator has to create need in the mind of a person, motivate him to adopt a particular behavior pattern and encourage and guide him while he is trying to change, so that the change is successful and permanent. Since motivation is the most important task of the health educator, he must know what are the *factors influencing motivation*. These factors are:

- Incentive (positive or negative)
- Cooperation
- Competition
- Jealousy and rivalry.

The psychosociological basis of behavioral change has been described above in detail. In more simple words, the process of change of behavior can be described to occur in the following phases:

Awareness: The individual becomes aware of a new idea or practice.

Interest: The individual evinces interest in the new idea and wants to learn more about it.

Evaluation: The individual weighs the pros and cons of the new idea.

Trial: The individual puts the idea into practice on trial basis and again assesses the pros and cons on the basis of initial experience.

Adoption: The individual adopts the practice permanently.

Conviction: Once an individual is convinced and accepts a new idea, he tries to convince others also to adopt the new idea.

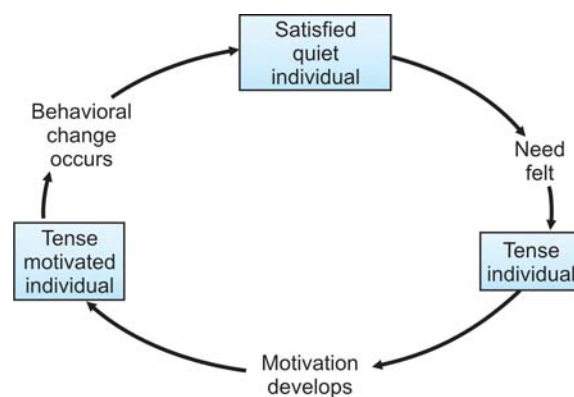


Fig. 29.1: Dynamics of behavioral change*

*An individual (or an organization) is basically quiet. He becomes tense when he feels a need. He becomes quiet again when tension is relieved. Need causes tension while activity relieves it. Here behavior is viewed as an activity which arises when there is a state of tension.

People often consider the following before accepting a new behavior:

- Is the behavior simple to adopt or does it require new skills?
- Is the behavior similar to existing practices or is it totally new?
- Is the new behavior that is desired, totally or partially compatible with current practices and knowledge?
- How much does the new behavior cost in terms of money, time and resources?
- How much impact including economic does the new behavior have on individual/family?
- Are benefits seen immediately or in the long-term?

Principles of Health Education⁵

The Challenge of Health Education

The words “Health Education” are very easily uttered. If the deep significance of this term, as implicit in the real meaning of education, is not understood, even well meaning doctors and health professionals may sincerely believe they have “given” health education to people when, in practice, they have merely lectured to them. No wonder they are surprised later when “health education” appears to have been ineffective. Hence it is extremely important that every member of the health team should know and understand the principles of health education.

The need for knowing the principles of health education is clearly highlighted by the following real story.^{7a} A team of health educators gave intensive health education to all the teachers in a particular taluk on all aspects of leprosy. Some time later, they returned to evaluate their work. At first, they were delighted to find that the teachers remembered perfectly all they had been told: leprosy is caused by *Mycobacterium leprae*; it is the least infectious of diseases; it is completely curable; and so on. But the evaluators’ delight turned to dismay when, on closer enquiry, they found that this new knowledge made no difference to the teachers’ old attitudes and practices. They still would not accept anything from the hands of a leprosy sufferer, would not allow a leprosy-affected child in the class and would not sit next to a leprosy patient on the bus. The education they had received remained merely sterile knowledge; it did not carry over into their daily lives.

This is the challenge of health education: that it should give correct knowledge, leading to sensible attitudes, resulting in healthy practices, to bring about a real change for the better, in the lives of the people.^{7a}

The Thirteen Principles

The aim of health education is to bring about a change in health behavior: If behavioral change is not brought about, health education is wasted. People

would not change their behavior unless they feel the need for the same. Hence people’s needs must be ascertained before starting the health education program. There may be a situation when the health problem is a serious one from the point of view of the health professional but the people do not view it as such and hence do not feel any need for changing their behavior. In such a situation, the health educator must first create a need for changing their behavior. In such a situation, the health educator must first create a need in the minds of the people and also stimulate interest in them to fulfill that need. Only then will health education succeed. Such a situation calls for a proper educational diagnosis about the different factors influencing the community, such as beliefs, prejudices, resources, perceptions, attitudes, etc. Since education aims at change in behaviour, the health educationist should have a good understanding of the sciences of psychology, sociology and anthropology. Also, in order to bring about a change in behavior, the health educator should make all efforts to rationalize his ideas and to reason them out properly, so that the audience may be able to internalize the relevant concepts.

Health education is not an artificial teaching learning exercise: The health educator has to be deeply interested in the community so that he should know the attitudes and practices and cultural values prevalent in the community. He should start not by demolishing the present attitudes and values but by building upon those that the community already has, slowly trying to bring about a change by guiding people’s thinking towards the desired change.

Health education should involve free discussion: There should be a free flow of communication between the people and the health educator. The health problems, their possible solutions, and the good and bad points of the solutions should be thoroughly and honestly discussed, without trying to conceal anything. This helps in clearing all doubts in the minds of the people. The health educator should remember that his job is not to instruct people about certain do’s and do nots, but rather to let them assess and compare themselves the new and old ideas on the basis of past experience, so that they may take their own decisions that appear beneficial.

Tell only what is needed: It is important that the health educator, especially if he is an expert, should not start telling all that he knows about the subject, including details of scientific research. He should clearly understand the health problem, the possible solutions and the level of knowledge and general education of the people. He should then limit the content of health education to telling only that which is necessary, important and relevant, using simple language. This does not, however, mean that he should be restrictive in his

approach. As already mentioned, he should encourage free and frank communication and thus should be willing to answer in detail if specific questions are raised by the audience during discussion.

Do not give conflicting information: The health educator should be consistent in what he tells the people. What is even more important, different health workers should not give contradictory message regarding a particular problem. Conflicting information from different sources often prevents people from following reliable health advice.⁸

Try to change only what needs to be changed: As mentioned in the beginning of this chapter, all health behavior practices may be clarified into three categories according to whether they are harmful, useful or inconsequential to health. Health behavior falling in the first category alone needs to be changed. An example of a practice inconsequential to health is giving honey to a newborn baby, Tulsi to a patient with fever and karela (bitter gourd) to a patient with diabetes.

These practices may not be useful to the person to whom the stuff is administered, but there is no evidence that they are harmful. There is no point in criticising the people for their beliefs and actions which they perceive to be beneficial, as long as they are not positively detrimental. Health education should focus attention on health behavior which is undoubtedly harmful. An example of the latter is the practice of not giving leafy vegetables to pregnant women in some parts of India. Some other *harmful beliefs and practices* are listed below:⁹

- For the first three days, the child should not be breastfed and colostrum should be discarded.
- No liquids should be given to infants when they suffer from diarrhea.
- Weighing the children at young age will cast an evil eye on them.
- Eruptive fevers like measles, chickenpox and small-pox are due to the anger of some Goddess, who needs to be appeased through prayers and offerings. No doctor should be consulted.
- Immunization induces high fever.
- Papaya is 'hot' food for babies.
- Planting, growing papaya and drumstick trees is inauspicious.

The educator should make himself acceptable: The health educator should always remember that he is to assume the role not of a professor but of an enabler. His task is to increase the ability of the people to understand their health problems, to find solutions for the same and to put those solutions into practice. In order to play the role of an enabler, the health educator must win the confidence of his clients. The following prerequisites are necessary for this:

- **He should be friendly and sympathetic:** The efficacy of health education depends not only upon its content and methodology of communication but also upon the personality of the health educator, the interest he exhibits in the client and the respect he commands from the latter. A good example is that of doctors and nurses, whom the patients give respect and whose interest in their welfare is unquestioned. Hence, it is essential that the health educator should have a friendly attitude towards the people and should be sympathetic about their problems, no matter how poor and primitive their lifestyle and how peculiar their problems.
- **He should be knowledgeable:** A person who does not possess correct and sufficient knowledge and is unable to answer health related questions asked by the people cannot be a good health educator.
- **He should practice what he teaches:** It is an old saying that example is better than precept. The teaching of a health educator who does not practice what he professes would sound hollow to the people. For example, people cannot take a doctor seriously who, while talking about the harmful effects of tobacco, himself keeps on smoking throughout the lecture.
- **He should talk the language of the people:** The health educator should adjust his talk to the individual or the group to whom he is talking. The choice of words, phrases, examples, etc. should all conform to the educational, social and cultural background of the client. Only then will meaningful exchange of ideas be possible. The tendency on the part of the technical experts to use difficult scientific terms in the interest of accuracy should be curbed if simpler terms can be used to convey the meaning broadly.
- **He should employ all possible methods of education:** Different educational methods may be specially suitable for different groups of people depending upon their age, sex, educational, background, etc. Also, some health messages may be more effectively conveyed through certain methods. The health educator should try to employ as many methods of health education as possible. This not only facilitates proper understanding of the topic under discussion but also makes it more interesting.

Use audio-visual aids whenever possible: Such aids make the topic more lively, interesting and comprehensible. They may be essential to explain certain technically complex messages. Knowledge depends upon perception while the degree of perception is directly proportional to the number of sense organs involved in perception. Audio-visual methods involve the use of two sense organs and are, therefore, better.

Choose a proper medium of communication: The medium will vary depending upon the nature of the target clientele for the health message. When the

number of target person is very large, mass media will have to be used.*

Communication must be good: The health educator has to communicate with people so as to get his message across to them. It is obvious that there cannot be good health education without good communication. The qualities of good communication are that it should be simple, clear and brief. The message should be delivered without any ambiguity.

Health education should be planned properly: It is always desirable to plan any activity or program properly. This is especially so in case of health education. Unplanned health education may be as good as wasted. To be effective, implementation of health education should be preceded by making an *educational diagnosis* and chalking out the details of the program in terms of content, methodology, evaluation, etc. Educational diagnosis is made by carrying out a study of the knowledge, attitudes and practices (*KAP study*) prevalent in the group or the community.

Health education should be provided in graded doses: It is futile to try to give too many health messages to the community at the same time. People have limited power for comprehending what a technical expert may think to be very simple themes. They cannot understand and assimilate in their mind too many facts at a time. Moreover, they need time to internalize various concepts and to try out the concepts learned. The health educator must provide sufficient time and opportunities to the people to try out the new practices advocated. He should thus aim at bringing about small changes in a graded fashion.

The health educator should put into practice the principles of community organization: Health education ultimately aims at enabling the people to identify their problems, think of solutions, decide upon a course of action and implement the same. The health educator should identify the opinion leaders in the community. He should involve the community in the process of identification of the problems and their solution, as also in the process of program planning, implementation and evaluation.

Characteristics of Effective Health Education

- Promotes actions which are realistic and feasible within the constraints faced by the community.

*There is often confusion regarding the terms educational materials and educational media. *Media* are needed to deliver the messages to target audiences. Thus, examples of media are TV stations, radio stations, schools, newspapers and magazines, etc. Strictly speaking, walls on which posters are displayed and the health educators and extension workers who convey messages are also media. Cinemas and mobile film vans, likewise, are media.¹⁰ Examples of *educational materials* are films, slides, posters, advertisements on television and radio and health articles in newspapers and magazines.

- Builds on ideas, concepts and practices that people already have.
- Repeats and reinforces information overtime, using different methods.
- Uses existing channels of communication such as songs, drama and story-telling, and is adaptable.
- Entertains and attracts the attention of the community.
- Uses clear, simple language with local expressions and emphasizes short-time benefits of action.
- Provides opportunities for dialogue and discussion to allow learner participation and feedback about understanding and implementation.
- Uses demonstrations to show the benefits of adopting practices.

Communication in Health Education and Training⁵

Communication deals with transmission of information or ideas and sharing and exchanging the same. Since education implies transfer of knowledge, communication is an essential component of education. The *three essential parts of a communication system* are the *communicator* or sender, the *communicatee* or receiver and the *message transacted* between the two. The *three dimensions of message* are the *code* (the symbols, e.g. the alphabet, in which it is transmitted), the *content* (the subject matter) and the *treatment*.

The *treatment* of a message refers to the manner in which the message is prepared, processed and delivered. Proper treatment of the message is most important for effective communication. The communicator has to use proper language, signs, symbols, examples, phrases, proverbs, anecdotes and reinforcing techniques (repetition, etc.) to make the message easily, fully and correctly understood by the communicatee.

Principles of Communication

Though communication is an everyday happening, it is not a simple process. Even when two people are communicating, there is no surety that they fully understand each other. The uncertainties of communication multiply when a group of people or the whole community is involved. A lot depends upon the abilities of the communicator and the way he prepares and delivers his message.

The principles of communication given below should be kept in mind by all health professionals involved in health education.

The sender's and receiver's perceptions should be as close as possible: Very often, two persons, though intelligent, find it difficult to understand each other because of their different perceptions. A good example of this is provided by comparing the communication a

student may have with his parent and with his teacher regarding some problem in physics or economics. It is often seen that while the parent, though knowledgeable in the subject, is unable to explain the problem properly, the teacher, a trained and experienced communicator, can do so very easily. The difference is attributable to the difference in perceptions. While the teacher is able to perceive the problem from the same angle as the student, the perception of the parent differs markedly from that of the student.

The message should be of good quality: A good message should be:

- Simple
- Accurate
- Adequate
- Clear
- Specific
- Significant
- Applicable
- Appropriate and timely
- Attractive or appealing
- In accordance with the laid down objectives
- In tune with the mental and socioeconomic level of the audience
- Practical.

Communication should involve as many sense organs as possible: As explained earlier, communication is more effective when more than one sense organ is involved. Thus when a message is delivered on the radio, only auditory sensation is involved. When it is on television, both auditory and visual senses are involved. The use of senses of touch, smell and taste, wherever applicable, would further improve communication.

Communication should be two-way: Unilateral communication from the sender to the receiver is not fully effective. It does not allow for any feedback from the receiver of the communication and hence it is not possible for the communicator to improve and modify his message and technique of communication according to the needs of the receiver. From the point of view of education and training, communication is complete only when feedback received by the communicator confirms that the message has been correctly received by the communicatee.

Direct communication is more effective: Communication is most effective when it is face to face. In this situation, more sense organs are involved and constant, immediate feedback is available, enabling the expert communicator to modify his own perceptions and message according to the needs of the communicatee. The efficacy of communication decreases as the communication becomes distant and indirect, (e.g. through the use of telephone, radio or print media). Depending upon the nature of communication, i.e. face to face or distant, communication skills may be direct

or indirect. While both these are important, direct communication skills are crucial to successful education and training in a class room situation. These will be described in the next section.

Three important skills are needed for communication:

1. **Talking and presenting clearly:** The goal of communication is to make sure that people hear, see and understand the message (idea or feeling) that is being shared with them. Therefore, it is important to talk, write, or present the message clearly and simply. Use words people understand; use few words as possible; Long lecture will bore people and they tend to forget. A method that is strange to people may not communicate the right idea.
2. **Listening and giving attention:** In addition to speaking clearly, educators must listen carefully in order to understand peoples' interests and ideas.
3. **Discussing and clarifying:** It is important to find out if the audience has understood the educator correctly. Questioning can make communication between people more accurate. Summarizing at the end is very effective in communication.

Nonverbal communication: Nonverbal communication refers to all stimuli generated by individuals in a communicative set-up without the use of words or voice. It involves body positioning, facial expressions, gestures, etc. It supplements the verbal variety of communication. This types of communication conveys inner meanings such as emotions, impulses and conflicts.

Education and Training Methodology

Every doctor has to act as an educator and trainer, whether as a faculty member in a Medical College, Trainer in a Training Institution, Lecturer in front of a group of laymen, Administrator responsible for Human Resource Development of his subordinates, Physician to his patient or, even, a parent educating his child. Hence it is essential for a doctor to have elementary knowledge of education and training methodology.

Systems Approach

The training process is a system in itself, comprising the following subsystems:

TRAINING NEED ASSESSMENT (TNA)

Before undertaking a training program, the trainer must find out what the trainees need to learn. If the trainer decides the contents of training on his own, he may regret because he may find later that the trainees already knew most of what was taught or that their basal level of knowledge was too low to comprehend

what was sought to be taught. He may even discover that the training program was not relevant to the job functions carried out by the trainees. Hence it is essential that TNA must be carried out before a training program is launched. This can be done by means of written questionnaire, by talking to prospective trainees or their supervisors and by actually observing how they perform their tasks in the real job situation.

FORMULATION OF OBJECTIVES

Once the TNA has indicated what the trainees need to be taught, the next step is to state the objectives of the training course in clearcut terms. This is done at two levels. First, the overall *general objective* of the training is stated. Second, the *specific objectives* are spelled out. It is important to remember that “a good training program should have its specific objectives in behavioral terms.” This means that the specific objectives should be so stated that they pertain to an observable and measurable change in behaviour. It is sometimes said that the objectives should be SMART, i.e. they should be specific, measurable, attainable, realistic and time bound. This will be clear from the following example. “The trainees should be able to appreciate the need for checking population growth.” This objective is in non-behavioral terms. Appreciation is only at psychological or mental level. It does not imply performance or psychomotor behavior. It is better expressed in behavioral terms as follows:

“At the end of the training the trainee will be able to list five reasons why growth of population must be checked.”

CURRICULUM DESIGNING AND IMPLEMENTATION

The next step is chalking out day-to-day curriculum. This should be done in such a manner that: (a) All areas suggested by TNA are covered; (b) There is a natural sequence in the curriculum, proceeding from simple to difficult topics; (c) Sufficient time is given to trainees to practise the skills taught.

The following three aspects of implementation of curriculum need detailed discussion:

Teaching Methods

There are several methods by which education, including health education, can be imparted. Broadly, the methods are of two types—formal presentation and group methods. In formal presentations, the speaker or communicator is on one side while the audience is on the other. These methods have limited scope for discussion and interaction. In group methods, the teachers and learners share the same platform and are thus able to indulge in free discussion.

Formal Presentation Methods

Lecture: This is the traditional method of teaching. It can be made more useful by using audio-visual aids and by including a question—answer session toward the end.

Dialogue: This is a formal presentation in which two experts carry on a dialogue amongst themselves for the benefit of the audience.

Symposium: This is a modification of the lecture method in which several experts are allotted different aspects of a particular topic. Sometimes, they may even speak on similar topics. Each person tackles the subject from his own point of view and thus provides variety to the audience in comparison to the monotony of a single long lecture.

Panel discussion: This is an extension of the dialog method. Here a small group of experts get in front of the audience and discuss amongst themselves various aspects of the subject. A chairman or moderator guides and coordinates the discussion.

Colloquium: Here a group of experts present themselves before the audience and respond to questions asked by the latter. This allows for sufficient interaction between the two. A moderator is needed to conduct the colloquium smoothly.

Group Methods

These methods offer large scope for discussion and free exchange of views among the learners themselves and among the learners and teachers, thereby facilitating learning. In the conventional method, a group of 5 to 15 persons discusses, a particular subject. In formal settings, such as in an academic or scientific institution, there is a chairman and a rapporteur and the subject is critically analyzed regarding a particular problem, its solution and the program of implementation. In informal settings, as in a roadside, street or village gathering, or in a group of patients and their relatives, the health educator follows an informal approach and stimulates the group members to respond to his suggestions and to express their views freely.

Besides the above, there are other group methods of education described below.

Focus Group Discussion (FGD): Here participants talk with each other under the guidance of a facilitator. Interaction among the participants stimulates each other. Use of FGDs: (i) To secure background information, (ii) To generate ideas for project, (iii) To get feedback from project, (iv) To learn and develop vocabulary for education program, (v) To formulate questions for the formal interview questionnaire/schedules and (vi) To interpret the available data.

Size and composition: Number of participants should range between 6 and 12. Participants should be representatives of the target population and must be homogeneous, i.e. having similar background and experience. Those who have participated in an interview of similar subject previously are excluded from FGD. Team for conducting FGD comprises of a facilitator, two recorders and a person drawing sociogram.

Conduction of FGD: At first participants are allowed and encouraged to talk to each other to establish rapport, with general non-controversial subjects of mutual interest. This will help the group to settle down to a comfortable relaxed beginning. At that time dominant and reluctant participants can be identified. Then after introduction of the participants, the purpose and scope of the investigation/enquiry are explained. Participants are told what is expected from them. Then permission is sought to use a tape recorder/video camera during the session (**Fig. 29.2**).

It should facilitate maximum interaction among participants. Participants sit facing each other, so each of them can see all the other participants. Participants should feel physically and psychologically comfortable. FGD can range from 1 to 2 hours, but it may be continued beyond this time schedule.

Advantages: Here information can be collected rapidly and sometimes it is more accurate. It is economical and reduces individual inhibition. FGD permits interaction between participants and facilitators, thus it provides considerable flexibility to the investigator to approach further. FGD can raise issues and concerns that the facilitator might not have considered initially.

Limitations: Information may not be generalizable concerning the whole population. It does not provide quantitative information and sometimes participants do not give sensitive information. Some participants may dominate the session and some becomes reluctant.

Buzz group or session: Here the entire group is subdivided into smaller group of about 10 to 15 each. Each small group discusses the problem during the time given. The problem allotted to different groups may be the same or may vary. After their deliberations, the groups merge and their findings and recommendations are pooled together and presented as the final document of the whole group.

Workshop: This is much like a buzz session except that it is more elaborate. Thus there are advisers, experts and specialist speakers who guide the whole group. The workshop usually extends over several days.

Conference and seminar: These are usually highly academic proceedings where several experts from different disciplines meet to deliberate on particular themes and to apprise others of the latest knowledge and research in a particular field. These advanced methods do not find much applicability in the usual type of health education.

Role play: This is a brief acting out of an actual situation for the benefit of the audience for better understanding. For example, a role play can be done to stress the importance of immunization or family planning and a suitable conversation can be developed for the same.

Demonstration: This is the actual carrying out of an activity in front of the audience or the group so that they may learn the concerned skill. For example, health workers may be taught the technique of intradermal BCG injection by actual demonstration.

Case method: Here a group of trainees is given an actual case in the form of a write up detailing the actual situation and problem. For example, an actual situation in a primary health center may be described and the trainees may be asked to give their views and approach towards solving the problem presented. In the context of medical studies, the case history of a patient presented to a group for discussion, as in a clinicopathological

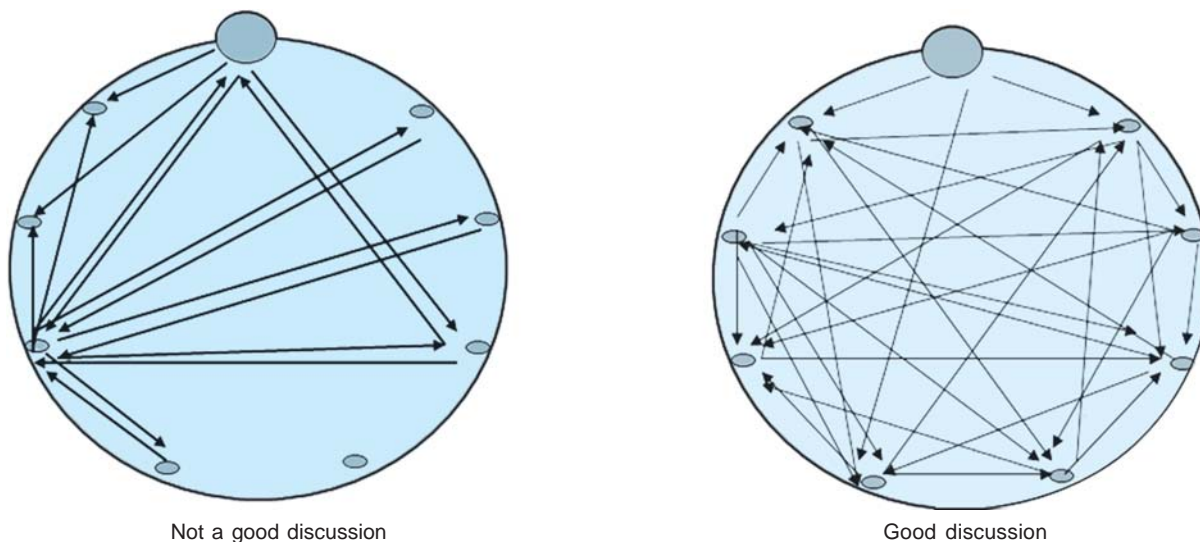


Fig. 29.2: Sociogram showing examples of *Not a good discussion* and *Good discussion*

conference, is an excellent example of the case method. A compilation of a number of cases for use in training situations has been published by the National Institute of Health and Family Welfare.

Quiz: This is an excellent method because everybody in the group is interested and full attention is ensured. The answers given by the participants help to reinforce knowledge of the entire audience.

COMMUNICATIONS SKILLS

A mention was made earlier about direct and indirect communication skills. The direct communication skills are absolutely essential for a doctor in order to be an effective teacher, trainer or health educator. A detailed description of these skills is not possible here due to lack of space. The more important skills are briefly described below.

- **Eye contact:** Speak to people. Look into their eyes (not through them, or away from them, towards the walls or the ceiling). Maintain eye contact with the audience.
- **Body language:** Make effective use of hand movements, gestures and facial expressions to reinforce your speech. Do not be glued to your seat. Move freely. Do not keep too much distance between yourself and the audience. Do not hide behind a desk or table.
- **Speech:** Your voice should be loud, slow and clear. Vary the volume, tone, and pitch of your voice. Do not be monotonous. Use pauses to emphasise important points.
- **Questions:** Ask questions to get confirmatory feedback that learning has occurred. Encourage the audience to ask questions. Clarify their doubts patiently and unambiguously.
- **Reinforcement:** Whenever the trainees exhibit positive learning, reinforce it by an appreciative nod or statement.

EDUCATIONAL AIDS

Various educational aids available nowadays make the process of education easier and more effective. The educational aids act as facilitators of communication between the sender and the receiver. The distinction between educational media and materials has already been clarified earlier. However, such distinction sometimes appears too theoretical. For example, a poster and a gramophone record are educational materials, while the wall or board on which the poster is displayed and the gramophone on which the record is played are the media. To avoid this confusion, it is more convenient to use the word educational aid which may include both the material and the media as convenient and relevant, a classification of various educational aids is given in **Table 29.1**.

TABLE 29.1: Classification of educational aids

<ul style="list-style-type: none"> • Audio aids <ul style="list-style-type: none"> – Megaphone – Microphone (public address system) – Gramophone – Taperecorder – Radio • Visual aids <ul style="list-style-type: none"> – Unprojected <ol style="list-style-type: none"> i. Black-board ii. Pictures iii. Cartoons iv. Photographs v. Posters, charts, graphs and maps vi. Flash cards* vii. Flannel boards* viii. Printed material: books, booklets, pamphlets, folders, etc. ix. Three dimensional aids (actual specimens and models) – Projected <ol style="list-style-type: none"> i. Epidiascope* ii. Transparencies iii. Projection slides iv. Film strip* • Audiovisual aids <ul style="list-style-type: none"> – Television – Video – Tape slides* – Cinema film • Traditional media <ul style="list-style-type: none"> – Puppet (string puppet, rod puppet, glove (hand) puppet, etc. – Folk songs – Folk dances – Drama
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*It may be mentioned that cinema has the highest reach in lower income strata while the press has the highest penetration in the upper income group.

It would be noticed from **Table 29.1** that a large number of educational aids have a visual content, either alone or in combination with the audio content. As such, it is worthwhile considering the characteristics of a good visual aid. These are brevity, simplicity, clear idea, proper layout and the right colour combination. Words should be bold and readable at a glance. For example, in case of a poster, it should be readable from a distance in a short-time. It should incorporate attractive words and dramatic illustrations. Size should generally be 20"×30". A poster should essentially convey a single idea and a single message.

EVALUATION

Evaluation is a systematic process to assess how much of a predetermined objective of a plan has been achieved.



Measurement indicates a qualitative or quantitative description of the change and value judgment is the assessment about the desirability of the change.

Whenever teaching or training is carried out, its effectiveness must be ascertained. In other words, the efficacy of training must be evaluated. Prolonged teaching by renowned experts is of no use if the students fail to demonstrate any change in their knowledge, attitudes or practices. Such teaching must be termed a failure and must be improved for the next training course. This can be done only when the change occurring as a result of training is measured and quantified. Here lies the importance of framing the training objectives in behavioral terms, so that they are measurable. Such measurement can be done by a simple questionnaire for assessing knowledge, by a specially designed questionnaire or interview for assessing attitudes and by observing the trainees during task performance for assessing skills. An identical evaluation should be carried out at the beginning of training course (pre-evaluation) and at the end (postevaluation), using the identical evaluation tools. When the comparison of pre- and postevaluation scores reveals statistically significant improvement, only then can one say that the training was successful.

Evaluation may be of different types. Outcome evaluation is carried out at a given point in time to compare actual performance with that planned in terms of both resource utilization and achievement of objectives. This is done to redirect efforts and resources. Impact evaluation based on the broader, long-term impact of a program or intervention. This is done some time after the program or intervention has been completed. Performance evaluation is the performance of individual learners in a course or program. Performance evaluation might be carried out either by formative or summative evaluation. Formative evaluation is the continuous monitoring of learning activities for obtaining a feedback. Thus it helps to provide early insights into a program. Examples being unit test, item examination, part examination, etc. While summative evaluation is conducted at the end of the course; some time after the program has been completed. Examples—university exam.

Planning of Health Education

It has been remarked earlier that unplanned health education is almost a waste of effort. Proper planning is, therefore, essential before launching a health education program. Given below are twenty principles of health education planning as suggested by the South East Asia Regional Conference held in 1986.¹¹

1. Planning for health education should be an integral part of all health planning.
2. Sound planning will be rooted in sound health facts and will apply these facts throughout the planning process.

3. Sound planning will incorporate sound principles and methods of education.
4. Health and education need to march together, neither of the two encroaching on the other, but both providing mutually reinforcing services.
5. Full recognition needs to be given to people's needs and interests and to the social, cultural and economic setting in which they live.
6. While developing programs, one must look at the hierarchy of needs, both among the people and the professionals, and find ways of amalgamating the two.
7. People should be involved in the planning process.
8. It is wise to start with simple things most likely to succeed and then move on.
9. It is best to deal with those aspects first that are regarded as important problems by the people themselves.
10. All resources should be utilized to define problems, collect facts, interpret the facts collected, draw conclusions, apply the conclusions reached and evaluate results.
11. Planning should be done with due regard to the ability to execute the plan.
12. There should be flexibility and continuity in planning.
13. Provision should be made for both short-term and long-term programs.
14. Ample time should be allowed while planning a long-term program of education.
15. There should be close cooperation between official and voluntary bodies.
16. Contributions of related disciplines should be utilized to the fullest.
17. All members of the health team should be involved.
18. Leadership is needed in the planning process.
19. There is need for administrative understanding, support and active participation.
20. Assessment of results is essential.

Most health programs planned nowadays have a component of health education, and rightly so. However, in practice, not much importance is given to health education during program implementation. Since the success of a health program is closely interlinked with successful health education, it is imperative that at every phase of health care program, equal importance should be given to the corresponding health education counterpart. This is clearly depicted in (Fig. 29.3) which shows the inter-relationship between service and educational components of a health program.

Levels of Health Education

Health education has to be imparted at various levels such as the community, a group, a family or an individual.

COMMUNITY APPROACH

The most important step in community approach is to encourage the people to find out their own needs and

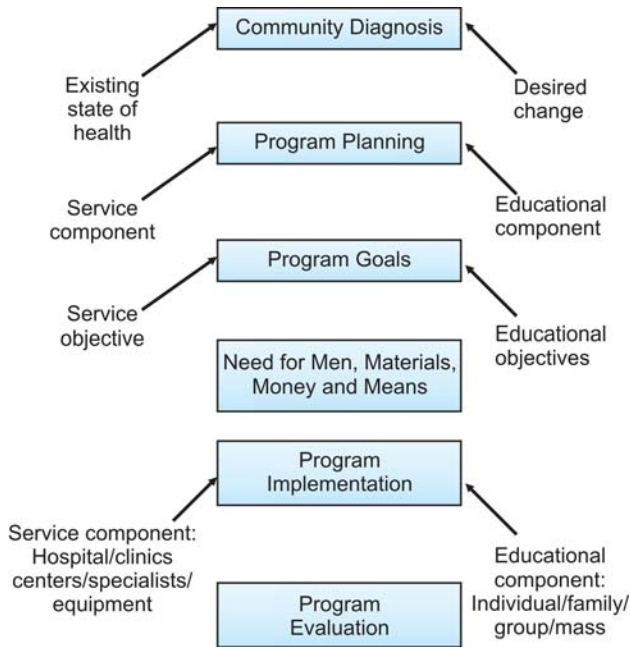


Fig. 29.3: Inter-relationships between service and educational components of a health programme

then involve them in planning, execution and evaluation of their schemes. The basic principle should be that of self help.

In urban areas, there are many laws and bylaws related to health. For effective implementation, people must be educated about the need for such laws and about the desirability of abiding by them in the interest of their own health and welfare. It is a common experience that most of these laws remain on the statute books only because of the fear of unpopularity in case of enforcement. A health education program should, therefore include educational efforts aimed at making the people aware of their own responsibility in obeying the laws.

From a practical point of view, the following principles of community approach are important, especially in a rural area:

- *Contact the people that matter in the community*
Such people may be:
 - Elected leaders, (Member of Parliament, Member of Legislative Assembly, Panchayat Sarpanch), an influential man in business, a landlord, a politician or a priest.
 - Local officers such as patwari, mamlatdar, BDO, police officer, etc.
 - Local medical practitioners.
 - Local voluntary and other health agencies. People readily listen to local leaders and an approach through them will produce quicker results. They should be taken into confidence and should be involved in planning as well as execution of the program.
- *Utilize all potential teaching opportunities* provided during real-life situations. However, it is crucial that

while utilizing a particular situation for health education, one should not neglect to give the best possible service appropriate to the situation, whether it is an epidemic or flood, and illness, pregnancy or delivery, etc. or a social or religious fair. It is useful to remember that people are highly responsive on such occasions.

- *Contact a needy and suitable party* to start with, such as a rich person in a village who has no latrine but who needs one and has space and money to build it. Create a demand and then motivate him for action. The same applies to construction of a sanitary well and soakpit.
- *Immediate provision of services* is essential once the party is convinced about its need. Strike the iron when it is hot. Fix up the time and date for construction, provide the materials and follow the project till it is finally completed.
- *Mobilize community forces* at this stage. Start a campaign and competition for healthy living. The person whose felt need has been fulfilled becomes the best tool for propaganda, education and demonstration to others.
- *Form a health committee* of interested people in the village, who can be entrusted with the task of continuing the community health program.

The ultimate success of a health scheme would depend on many factors such as the nature, extent and immediateness of the benefit which the villagers feel they would get from the scheme. It also depends on the extent of their willing cooperation and active participation, on financial commitments expected from them and on local conditions. Team spirit and tact on the part of health and other extension staff are vital to the success of a program.

Group Approach

The group approach saves time, induces acceptance of ideas, makes people more responsible about their own health and lets them adopt preventive and curative measures themselves to maintain or restore health. Examples of groups are clubs, social organizations, pregnant mothers (in an antenatal clinic), school children, factory workers, Mahila mandals, etc. This approach is more rewarding, especially when the problem affects the group directly, (such as family planning in married adults). The *steps for a group approach* are:

- *Introduction*: Introduce yourself and talk about personal problems of the group members very tactfully, using simple terms and language.
- *Modification of attitude and behavior*: These are determined by social and cultural forces. Mere information is not enough to change attitude and behavior. Health education must seem to satisfy certain social needs and fulfill some purpose before people respond to it.
- *Communication*: Didactic approach by tools such as a lecture, a film or a posters involves one-way traffic.

Health education should be a two-way traffic or a two-way method (Socratic approach). Everyone in the group should be encouraged to talk, ask questions, express his ideas and take decisions regarding a health practice. Group meetings may be more useful if they are arranged as health seminars, panel discussions, conferences, workshops, etc. in which the group members are allowed to express their views or ask questions freely. In the two-way method, there will be a feedback to the health workers as well. It is good to remember that information trickles downwards and experience moves upwards.

Family Approach

Health education should be imparted to all the family members. The school child will be listened to at home for cleanliness and other health concepts learnt in the school if the parents have been already motivated. The mother is the centre for action but the father often plays the dominating role. If the mother, the father and the child, all are given the same health education message through their respective channels (female MPW, male MPW and school teacher respectively), the net effect of the health education will be much more due to synergistic effect.

Individual Approach

- *Infants:* Health education is done by inculcating proper habits (such as bladder and bowel evacuation), giving nutritious and wholesome foods and keeping the child clean at all times. Such training and activities stimulate the development of healthy habits.
- *Toddler stage and early childhood:* The watchful nature of the child at this age is specially suitable for educational purpose. The child watches his parents, sibs or neighbors and copies them. Whatever habits they have (smoking, cleaning of hands, etc.), the child picks them very fast.
- *School age:* Health education is imparted through:
 - Healthy school living in well-ventilated rooms
 - Use of clean latrines and urinals
 - School books and teaching curriculum
 - Physical education and games
 - Personal examples set by the teachers and the advice and guidance given by them
 - School meal programs which act as practical situation for nutrition and diet education.
- *Adolescent age:* It is a delicate age because of important changes in sex and physique. Besides other things, sex education regarding anatomy and physiology of sex organs has also to be given. Hygiene of sex organs (removal of smegma, menstrual hygiene) is also important. Special attention has to be paid to educate the adolescents about prevention of pregnancy and sexually

transmitted diseases, including AIDS. This has become crucial because of increasing permissiveness in society all over the world. A recent WHO and UNFPA sponsored study on sexual behavior of young people has revealed the following facts about first sexual encounter of adolescents:

- The sexual relation develops over a period of time and does not take place between two strangers;
- The boy shows more interest than the girl;
- Contraception is not used;
- What substitutes for contraception is a little assurance from the boy that the girl need not worry about pregnancy;
- One-third of respondents believe that contraceptive methods cause infertility;
- No reference is made to the possibility of contracting sexually transmitted diseases, including AIDS;
- One pregnancy is suspected, the boy resists responsibility;
- Self-induced abortion in unsafe circumstances is considered frequently, though not always acted upon.¹²

The above findings indicate the areas in which sex education should be focussed for adolescents.

- *Adults:* There is need to create a desire to bring up the family in healthy conditions and to take part in community health programs. Education about family planning, antenatal care and child rearing is of importance.
- *Old age:* Health education from childhood to adulthood stresses upon promotion of health and prevention of disease. Old age poses some special problems. Here the aging individual has to be taught about how to cope with the inevitable disabilities associated with old age such as cataract, loss of hearing, falling of teeth, menopause, osteoporosis, prostatic enlargement, etc. Appropriate timely advice regarding these problems goes a long way in reducing the anxiety and suffering of old people.

Experience and Examples of Health Education

Effectiveness of health programs can be markedly curtailed if appropriate health education is not included as a component. Underprivileged people may be overawed by those in authority and may not refuse outright something suggested by an official. They may carry out the suggested task even if they have to incur some financial expenditure. However, this activity on their part may be purely passive or involuntary, without any change in attitude or behavior. A good example is the latrine construction carried out with 50% subsidy from the government as part of the community development program. Even though many latrines

were constructed, they largely remained unused because there was no motivation and hence no behavioral change on the part of the people. A real good health education program would have averted this fiasco.

Similarly, no special efforts were made to educate the people or to involve them directly when the National Malaria Control Program was launched. It was thought that the act of DDT spray itself was sufficient to serve as means of education because people welcomed such spray. Things went on quite well in the early stages and this was taken as the public approbation of the great value of DDT in malaria prevention. In reality, people were thankful because of the collateral benefits of DDT, such as reduction in the nuisance of flies, fleas, culex mosquitoes, bugs, ants, cockroaches and other insects. Very few persons understood the role of DDT in preventing malaria through destruction of the vector species. It was not surprising, therefore, that the tremendous initial response to DDT spray dwindled when DDT started losing its effectiveness against insects other than the malaria vector. Malaria workers started facing large scale refusal to DDT spray in most areas. There were complaints about the quality of DDT and about malpractices of the staff, not because DDT had lost its effectiveness against the vector species but because the collateral benefits had disappeared. This brings home very vividly the need and importance of talking the people into confidence and educating them about the program before implementing the same.

Health education carried out well enough and long enough, can be demonstrably effective. It is now well known that the prevalence of smoking is slowly declining in the west and increasing in India. This reflects simultaneously the response to intensive health education drive in the West and a lukewarm approach in our own country. To give another specific example, it has been reported that North Karelia, a country in eastern Finland with the highest mortality from heart disease throughout the world 20 years ago, has slashed its death rates by half because of an all out program to change the diets of the community and to persuade smokers to quit smoking. It is important to remember that it is easier to instil healthy lifestyles in the young than to change bad habits in adulthood. Based on this, Philippines has launched an all out program to teach children how to have a healthy heart, right from their kindergarten days.¹³

An example of successful health education program in prevention of cancer has been described earlier in the chapter on noncommunicable diseases.^{13a}

Child to Child Program

It was initially conceived and started by David Morley and his colleagues at the Institute of Child Health and

Institute of Education, University of London in 1977. During the early years' the major emphasis was on better care of younger sibs by a child. In its extended form a major emphasis is now placed upon its health educational aspect. With this end in view, the NCERT has successfully experimented with the child to child program in municipal primary schools, using an activity based approach. It is proposed to teach the children the basic health and development concepts with the aim of improving their own knowledge, as well as using this child power to communicate relevant messages to younger children, parents and the community.¹⁴

The child to child program is currently spread over 75 countries. Its objectives are as follows (i) To improve the levels of health, nutrition and development of school-going children through child to child activities; (ii) To make learning a relevant, meaningful and enjoyable experience for children; (iii) To enable school-going children to make qualitative improvements in the life of their younger sisters, brothers, parents and neighbours, thus applying the facts learnt in school to daily life; (iv) To improve the school and neighborhood environment through organized activities.

The activities under the program may be of the following types:

- *Child to child*: The child may be involved in providing care for younger brother and sisters or other younger children.
- *Child to family*: In certain circumstances the child may exert an influence on the health practices of his parents and other family members.
- *Child to community*: Children as a group may influence the health practices of their community through songs, plays, puppet shows, etc.
- *Child to environment*: The child may be involved in activities aimed at improving the quality of the environment, e.g. sanitation, tree planting, etc.¹⁴

Education and Training System in Health and FW Institutions

The Government of India established 47 Health and Family Welfare Training Centers in 1960's in various parts of the country. The HFWTCs are supposed to get guidance and support from the so called Central Training Institutes, listed below:

- National Institute of Health and Family Welfare, New Delhi.
- Central Health Education Bureau, New Delhi.
- All India Institute of Hygiene and Public Health, Kolkata.
- Family Welfare Training and Research Center, Mumbai.
- Rural Health and Family Welfare Training Center, Gandhigram, Tamil Nadu.

The training system in health and family welfare has proved to be grossly inadequate. Two major reasons

for this are: (a) The number of HFWTCs initially established at the scale of one centre for one crore population, has remained the same, though population has doubled; (b) The so called CTIs have not been able to provide adequate guidance and support to HFWTCs; (c) The HFWTCs are starved of funds and facilities and the HFWTC faculty has low morale due to poor promotional avenues.

Realizing the importance of well-trained personnel for effective health care delivery, the government of India launched, with World Bank support, a National Training Project, comprising India Population Project VI and VII, in eight states (IPP VI in Andhra Pradesh, MP and UP; IPP VII in J and K, Haryana, Punjab, Gujarat and Bihar). As a consequence the current pattern of training in health and family welfare is as follows.¹⁵⁻¹⁷

- *National level:* National Institute of Health and Family Welfare, New Delhi.
- *State level:* State Institutes of Health and Family Welfare. Eight SIHFWs have been established in the 8 IPP VI and VII states, besides Orissa, Karnataka, Assam and Rajasthan.
- *Regional level:* HFWTCs. Regional Training Centers or RTCs, each serving about 10 million population, have been established in the IPP states.
- *District level:* District Training Center and District Training Team.

As regards health education, the Central Health Education Bureau (CHEB) is a part of the administrative organization of the Director General of Health Services, Government of India. Similarly, states have a State Health Education Bureau (SHEB) in the Directorate of Health. Each District has a District Health Education Unit at District level as part of the District Health Organization, and Block Health Unit at Block level as part of the Primary Health Unit.

The *Central Health Education Bureau* was established in 1956. Since then, it is engaged in strengthening the concept of health education and giving it a rightful place in the health programs. The Bureau coordinates and promotes health education work in the country. It has six technical divisions, namely, Training, Research and Evaluation, Field Study and Demonstration Center (Urban and Rural), School Health Education, Health Education Services, and Media and Administrative Section.

The main function of the Bureau are:

- To train key health and community welfare workers in health education,
- To prepare and produce health education material, both printed and audiovisual, for the general public and for training purposes,
- To coordinate and conduct research in health behavior and health education process,
- To help in implementing health education programs for school going population, for youth out of school and for teacher trainees of different categories, and

- To coordinate the activities relating to international assistance for health education.

The CHEB has established a Central Health Museum and organizes health exhibitions at various levels. It brings out several publications on health education. It organizes training of doctors, health visitors, nurses, health educators and school teachers, etc. It conducts a one year diploma course in health education under the auspices of the University of Delhi. In addition, it also conducts a three months certificate course, as well as short-term training courses suited to the needs of different categories of personnel.

The Research Unit conducts studies in health habits, values and beliefs of people. It also encourages social sciences research on health subjects in the universities and other institutions.

Besides the CHEB, the DAVP (Directorate of Advertising and Visual Publicity) also carries out health education activities.

IEC Training Scheme

The Information, Education and Communication Training Scheme was launched by the Ministry of Health and Family Welfare, with financial assistance from USAID, on 17th November, 1987, in 4 Hindi speaking States of UP, MP, Rajasthan and Bihar in a phased manner by covering during next 6 years a total of 68 Districts. There was general consensus that the scheme had been useful. Though USAID assistance was no longer available, the government decided not only to continue it beyond March 1993 but also to extend it to the remaining Districts of the 4 Hindi speaking states and other states of the country with poor demographical indicators. Thus, the Ministry of Health and Family Welfare approved the Scheme to continue as a plan scheme under the VIIIth Plan and made budgetary provisions as part of the IEC Division of the Ministry.¹⁸ The additional states included were West Bengal, Orissa and Assam.

Rationale

Crucial to successful implementation of the Health and Family Welfare Programs is the performance of change agents, i.e. male and female workers at the grassroot level. Some of the important variables that influence performance at this level are the nature of workers' transactions with villagers as well as their competence in terms of the required knowledge and skills. Predictability of workers' visits to villages, and villagers' awareness of such visits, add to the reliability of services and contribute positively to establishment of rapport with the villagers. Similarly, efforts to improve the skills of workers on a continual basis are also significantly beneficial to enable them to perform their job more effectively. At present, though the workers are expected

to visit villagers, the visit schedules prepared for them (based on monthly calendar) neither help workers to visit villages at regular intervals, nor improve villagers' awareness of such visits. Training programs for workers are largely institution-based and such programs mainly concentrate on imparting knowledge rather, than skill development and problem solving. Even for such training programs the worker gets opportunities for getting orientation after long gaps. Presently, few training programs provide opportunities for on the job training.

The nature of supervision at various levels needs considerable improvement. Multiple levels of supervision, lack of regular supervisory visits and the fault finding nature of supervision have to be changed to supportive, innovative and problem solving type of supervision at various levels. Multiple supervisors also often work in isolation, with little effort to share experiences with each other. As a result, more often than not, supervision becomes routine and ritualistic and loses its potential as a supportive input in the organization.

Objectives

The objectives of the project are to: (1) Increase the reach of services by making visits of workers and supervisors more predictable and regular; (2) Improve quality of services through knowledge and skill development of workers; (3) Make supervision more oriented towards problem solving; (4) Link supervision with training at various levels; (5) Concentrate on local field problems, both for development of training materials and their use; (6) Combine interpersonal communication strategy with mass media approach; (7) Streamline supply systems to meet the local needs of health and family welfare units; (8) Establish relationship between various levels and elements of the system; and (9) Improve performance levels through continuous interaction with village community volunteers.

Major Components

To achieve the above mentioned objectives, efforts are concentrated mainly on four components. These are: (i) Visit schedules; (ii) Training; (iii) Supervision; and (iv) Monitoring and evaluation.

VISIT SCHEDULES

Villagers mainly follow the days rather than dates. Therefore, under the IEC scheme, the tour programs of health workers are drawn as a weekly schedule rather than a datewise calendar schedule. The new system attempts to make the visits regular and predictable by assigning a particular week-day in a fortnight to a particular village. To make villagers aware of visits, Weekly schedules

of workers are circulated to villagers. Similarly, the visits of supervisors to village and subcenters also follow a predictable pattern. It is difficult for health workers to contact each household on every visit. To establish a link between villagers and workers, the village is divided into units of twenty households. From each of these twenty households, one influential person, preferably a female, is identified, trained and involved in all health and family welfare activities in the village. This approach not only ensures better coverage but also involves community members in educational and service delivery activities. The health workers visit those households identified by the link persons and requiring health and family welfare education and services, on priority basis.

TRAINING

Institution based training has its own relevance but its ability to cover all workers at regular intervals is limited.

Training should not only cover technical aspects of programs but also focus on problem solving skills of workers. This is possible only when the workers are given training in the work situation by their immediate supervisors at regular intervals. So the effort in this project is to improve job performance of workers through training by taking unique local level problems into account. Training in this project is conducted at sector, PHC and district levels according to a predetermined schedule. Two types of training programs are contemplated at all levels: one, initial training of longer duration; and the other, regular training of short duration. While initial training is a one time activity to introduce the IEC project, the regular training is a continuous process and forms part of the system.

The contents of training programs concentrate on two aspects; one, on technical topics and problems based on seasonal variations at the PHC level; and second, on problem solving and management aspects at sector and subcentre levels. In both cases, content is suitably modified to fit into local needs and requirements.

SUPERVISION

There are multiple supervisors for each worker. Given, this, the importance of immediate first line supervisors has often been neglected. At present, the nature of supervision has become almost routine. Each supervisor, during brief visits to subcentres and PHCs, concentrates only on three aspects. These include: (1) records; (2) target achievement; and (3) new instructions. To make supervision more effective, it is necessary to introduce the concept of teaching in supervision and convert the present nature of supervision into supportive and skill development type. This project envisages giving equal importance to all supervisory levels, constituting supervisory teams, and finally integrating supervision with training and visit systems.

MONITORING AND EVALUATION

Success of any program depends on ability to monitor and evaluate programs adequately and accurately and to take corrective action, if necessary.

The project aims at designing simple information system to identify the local health and family welfare needs and to pinpoint local problems and issues. These provide a major input into the training programs.

Role of HFWTCs

The HFWTCs play an important role in the IEC scheme. Their specific functions in this context are: (i) To organize training program; (ii) To provide assistance to district supervisory-cum-training teams; (iii) To develop locally relevant or adapt centrally developed training material; (iv) Providing additional skills to health workers, specially in the area of interpersonal communication.

Social Marketing

Social Marketing (SM) is merely the application of commercial marketing principles to advance a social cause, issue, behavior, product, or service. Advertising and other communications are central to social marketing. Social marketing is a cyclical process involving six steps: Analysis; Planning; Development; Testing and refining elements of the plan; Implementation; Assessment of in-market effectiveness; and Feedback.

Kotler and Gerald Zaitman in 1971, first presented the idea of social marketing. This concept combines traditional approaches to social change with commercial marketing and advertising techniques. Its originators defined social marketing as “the design, implementation and control of programs aimed at increasing the acceptability of a social idea or practice in one or more group of target adopters”.

Social marketing makes use of methods from the commercial sector: setting measurable objectives, doing market research, developing products and services that correspond to genuine needs, creating demand for them through advertising, and finally marketing through a network of outlets at prices that make it possible to achieve the sales objectives.

The difference between commercial and social marketing thus lies not in the methods they use but in their content and objectives. Social marketing is a somewhat more complex concept, however, and sometimes also less effective than its commercial counterpart, since it aims to influence people’s ideas and behavior (for example, to make them give up smoking). Moreover, marketing social products with a tangible base is even more complex, as demand has to be created for the idea or product concept, such as family planning, as well as for the tools or product itself, such as condoms.

Commercial marketing, in contrast, simply tries to steer existing patterns of thought and behavior in a certain direction—convincing consumers that a certain brand of toothpaste is superior, for instance, rather than that it is important to brush the teeth regularly.

Social marketing’s products are ideas and practices.

Social marketing is distinguished by its emphasis on so-called nontangible products ideas and practices as opposed to the tangible products and services that are the focus of commercial marketing.

Elements of Social Marketing

UNDERSTAND “CUSTOMER NEEDS”

Social marketing aims to “reach” one or a number of target groups in order to initiate and effect changes in their ideas and behavior. The starting point of social marketing, therefore, is getting to know the target audience thoroughly through market research: its social and demographic makeup (economic status, education, age structure, and so on), its psychosocial features (attitudes, motivations, values, behavioral patterns), and its needs.

DISTRIBUTION CHANNELS: MAKING THE “PRODUCT” AVAILABLE

Mass media are undoubtedly the most important “vehicles” for creating awareness of social products as well as for distributing nontangible products. But their effectiveness varies greatly. In urban areas, depending on the target group, television, cinema, and radio (with due attention to the right broadcasting time) as well as magazines, newspapers, posters, and other print media can be effective. In rural areas, often only radio plus traditional “media” such as folk theater, puppet shows, and song and dance performances are appropriate.

As a rule, the communication channels selected should be ones the target audience comes into contact with on a regular basis as well as perceives as being credible, since familiarity with a medium and with the performers makes it easier to get the message accepted.

Tangible products (such as condoms for family planning), which may form part of a social marketing campaign, can be provided through various channels: house-to-house or a local distribution center, by post, direct sale, and so on. They can be given for a fee or free of charge. The decision on the marketing channels to be selected how many, what kind, and where depends on many factors such as nature of the product, costs, the size and location of the target population, and its consumption habits.

PRICING

Prices fulfill various marketing functions. For one thing, they regulate the target groups’ access to products. Particularly in poor countries, higher prices impede

access whereas lower prices facilitate it. For another, price serves to position a product, as it is frequently viewed as an indicator of quality and attendant prestige value. High price is often equated with high quality.

OPPORTUNITY COSTS—THE COST OF ADOPTION

The total cost of adopting a social idea or practice often goes beyond the monetary price alone, as further cost-related factors are typically involved: the time lost or spent (in traveling and waiting, for example, and the outlay this entails) together with perceived barriers to adoption—be they psychological, social, or physical. Reducing such costs and creating incentives to adopt and maintain the new idea or practice overtime is thus another central task of social marketing.

Examples of Social Marketing

Social marketing techniques have been particularly successful in the health field. Examples are given below.

IN DEVELOPED COUNTRIES

- The National Cancer Institute used marketing techniques to change the behaviors of US women and health professionals regarding breast cancer detection;
- The National High Blood Pressure Education Program, using these techniques, has increased patient compliance with antihypertensive regimens;
- The American Cancer Society developed a sound marketing program to convey the benefits of giving up smoking, especially for teenage girls.¹⁹

IN DEVELOPING COUNTRIES

- In Honduras, oral rehydration salts (ORS) were first marketed in 1980 under the brand name Litrosol. Litrosol was heavily advertised on television and radio, and widely distributed through the existing health care system and by local village volunteers. By the end of the first year of the ORT campaign, 49% of the mothers had actually used Litrosol and 71% could recite the radio jingle composed for this campaign. More importantly, during the two-year campaign period, diarrhea-related mortality in children under the age of five dropped from 48 to 25%.
- Similar ORS marketing results have been achieved in Egypt and Gambia. About 50% of Egyptian mothers had used ORT after one year of the program and over 50% of cases for the second year of the campaign in Gambia used ORT.
- Contraceptive Social Marketing (CSM) programs are well-established in India, Bangladesh, Sri Lanka, Thailand, Nepal, Colombia, El Salvador, Jamaica,

Mexico, and Egypt. In India, Nirodh has become synonymous for condom and is, in fact, better understood by people. Mala-D and Saheli are other examples of social marketing of contraceptives in India.

Social marketing has proved successful despite significant obstacles like cultural and religious resistance, lack of knowledge about the topic, illiteracy, and pricing constraints. But SM is no shortcut for success; it requires both experience and sensitivity to local conditions.

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World Health Day 2005: Make Every Mother and Child Count

Maternal and Child Health

Family Welfare covers both Family Planning and MCH. Family Planning will be discussed in the next chapter. MCH services are described here.

Mothers and Children as a Special Group

Public health activities are concerned with the well-being of all people irrespective of age, sex, race or other characteristics. However, two groups, i.e. women in the reproductive age group and children, especially under fives merit special attention. There are three reasons for this:

1. By virtue of their numbers, mothers and children are major consumers of health services. They comprise approximately two-thirds of the population in the developing countries. In India, women in the childbearing age (15 to less than 45 years) constitute 21.7% and children under 15 years of age 37.3% of the total population. Thus, together they constitute nearly 60% of the total population (1991 census).
2. These groups are subjected to marked physical and physiological stress, which, if not cared for, may cause serious deviation from normal health.
3. They are exposed to unusual risks of widespread infection, poor nutrition and hazardous delivery, which may cause death or impairment of health. The high occurrence of morbidity among women and children is reflected in the fact that in a seven village study, two-thirds of the total morbidity in the entire scheduled caste population studied was due to MCH related cases.¹

The protection of the health of the expectant mother and her children is of prime importance for building of a sound and healthy nation. In spite of this, the concept of maternal and child health was put into practice only recently (after 1900 in the West and after 1950 in India).

The maternal and child welfare movement in India started with attempts to train the indigenous 'dai' (Traditional Birth Attendants, TBA) by Miss Hewlett of the Church of England Zenana Mission in India in 1866. Wives of officials returning from foreign countries started some services through voluntary

societies in big towns, such as holding of mothers' classes and training of indigenous *dais*. Lady Chelmsford was much interested in this work and she established the All India League for maternal and child welfare in 1919 and opened Health Schools for training of health visitors in many big towns. Later on the League became incorporated with the Red Cross Society. Training of midwives, assistant midwives and *dais* was also conducted at some places.

Till 1953, the MCH services in the districts were patchy and were rendered through maternity homes or trained midwives. The latter were under the control of the civil surgeon and their services were mostly curative and institutional. From 1955 onwards, MCH services were linked with primary health centers in the rural areas. In urban areas, these services are rendered through MCH centers or maternity homes run by the Local Bodies.

Remarkable progress has been made in the saving of lives of expectant mothers and infants through the MCH services. This is particularly noticeable in the advanced countries. These services were initially started with the sole aim of reducing infant and maternal mortality. At present, these services definitely play a positive role in the welfare and health of the mother and the child. The present scope of these services is therefore very broad.

Mother and Child as One Unit

The mother and the child should be considered as one unit for providing health services because of the following reasons:

- During the antenatal period the fetus is part of the mother. The period of development of the fetus is about 40 weeks. During this period, it obtains all necessary supplies of nutrients and oxygen from the mother's blood.
- The health of the child is intricately linked to the mother's health.
- Certain diseases afflicting the mother during pregnancy can have their deleterious effects on the health of the fetus.
- Even after birth, the child is dependent for its feeding upon the mother, at least in the first year of life.

- During the first few years of life, the child usually accompanies the mother during her visits to the health facilities and there are few occasions when services to the mothers and children are not simultaneously called for.
- The mental and social development of the child is also dependent on the mother. The mother is the earliest teacher of the child. The death of the mother causes a maternal deprivation syndrome in the child.

It is for the above reasons that the mother and the child are treated as one unit for provision of health services usually referred to as MCH Services.

Definitions

Some important terms in the context of MCH are given below. These are in addition to those already given in the Chapter on Demography.

Women of reproductive age group: Women belonging to 15 to 44 + years of age.

Child: Male and female below 15 years of age.

Infant: A child below the age of one year.

Infant mortality rate (IMR): The number of infant deaths per 1000 live births in one year in a community or country.

Maternal mortality: A maternal death is defined as the death of a woman while pregnant, or within 42 days of termination of pregnancy, irrespective of the duration and the site of pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes.^{1a}

Maternal mortality ratio (MMR): The number of maternal deaths per 1000 (or per 100,000) live births in the year in a community or country.

Prenatal Period

This is the period of pregnancy from the moment of fertilization of ovum till the time of delivery. It has three components, each related to the developmental stage of the conceptus as follows: (i) Ovum, 0 to 14 days; (ii) Embryo, 14 days to 9 weeks; (iii) Fetus, 9 weeks to birth.

Neonate: A child of 0 to 4 weeks of age.

Neonatal mortality rate: The number of neonatal deaths per 1000 live births in a year in a community or country.

Preschool age children: Children aged 1 to 4 years (4 years here means 4 + years, i.e. less than 5 completed years).

Under-five mortality rate (U-5MR): Annual number of deaths of children under five years of age per 1000 live births. This indicates the probability of dying between birth and 60 months of age.

Low birth weight: Children born with a birth weight below 2500 g.

The Nature of MCH Problem

The level of maternal and child health is reflected in maternal morbidity and mortality on one hand and in pediatric morbidity and mortality on the other, which will now be described. However, the major factors responsible for MCH related problems are different in developing and developed countries. In the former, including India, the three main factors are (i) Malnutrition, (ii) Infection, (iii) Consequences of uncontrolled reproduction. In the industrialized countries the main factors are (a) Perinatal problems, (b) Congenital malformation, and (c) Behavioral problems.

Maternal Morbidity and Mortality

Maternal Morbidity

Common diseases associated with pregnancy are the following:

Anemia: It is the most common ailment during pregnancy. It is more common in the poor but is not uncommon among the well to do. The most common cause is nutritional. Other causes are hookworm infestation, intercurrent infections, ante or postpartum hemorrhages, persistent vomiting, abortion and repeated pregnancies. Severe anemia may give rise to congestive heart failure. It is estimated that 56.8% pregnant and 35.6 nonpregnant Indian women have iron deficiency anemia.² Premature labor and low birth weight babies and high perinatal mortality are common outcomes of severe anemia.

Urinary tract infections: Pyelonephritis or cystitis, especially due to *E. coli*, are very common during pregnancy. Acute infection may simulate malaria, because of high fever and shivering. Frequent and burning micturition is often present.

Other common antenatal problems: Antepartum hemorrhage, toxemia of pregnancy, osteomalacia, backache, hypertension, etc. are other common problems in pregnancy.

Puerperal sepsis: Infections during pregnancy, labor and puerperium due to lack of personal hygiene or septic procedures result in a lot of suffering to the mother in the form of acute or chronic inflammation of ovaries, tubes, endometrium, cervix and vagina. Leukorrhoea may persist for years. Chronic infection of cervix may predispose to cancer. Sterility can follow acute or even chronic salpingitis.

Complications of delivery: Since most of the deliveries take place at home by untrained *dais* under unhygienic conditions, perineal tears, cervical damage, prolapse and displacement of uterus, and laxity of vagina are common consequences of poor obstetric care. A pregnant woman may have abortion or premature delivery may develop or postpartum psychosis.

Infections: Pregnancy causes a serious drain on the already poor constitution of the mother and predisposes her to various infections, including malaria, etc. resurgence of which is causing lot of problem in some parts of the country. A common outcome of malaria during pregnancy is abortion.

It is estimated that for every maternal death, 20 women suffer from ill-health and lowered efficiency. The most important point worth consideration is that almost entire maternal morbidity is preventable by proper care and supervision of the mother during pregnancy, delivery and puerperium.

Maternal Mortality

It includes all deaths associated with pregnancy, delivery or puerperium. The number of such deaths per 1000 live births is called maternal mortality ratio.

Maternal mortality was very high in India before independence. It varied from 1400 to 2200 per 100,000 live births prior to 1935, was estimated to be 2000 in 1938, and dropped to 1000 in 1955 and to about 500 in 1965.³ It was estimated to be 450 in 1976. The goals set for 1985, 1990 and 2000 AD were 300 to 400, 200 to 300 and less than 200 per 100,000 live births.⁴ For the period 1990 to 1999, WHO estimates that the maternal mortality ratio for India was 410 per 100,000 live births. In comparison, the MMR in developed countries ranges from 5 to 30 per 100,000 live births.³ Countries with high under-five mortality rate have a high maternal mortality. The low maternal mortality rates in the Western countries are attributable to the availability of excellent maternal care, each maternal death there being thoroughly investigated for the underlying cause.

Among developing regions, the adult lifetime risk of maternal death is highest in sub-Saharan Africa (1 in 31), followed by Oceania (1 in 110) and South Asia (1 in 120), while the developed regions had the smallest lifetime risk (1 in 4,300).⁵

MMR estimates 2007-09:⁶

- Decline in MMR estimates in 2007-09:
 - For India: 212 per 1,00,000 live births.
 - In Empowered Action Group (EAG) states and Assam: 308 per 1,00,000 live births.
 - Among Southern States: 127 per 1,00,000 live births.
 - In Other States: 149 per 1,00,000 live births.
- States realizing MDG target of 109 have gone up to 3 with Tamil Nadu and Maharashtra (new entrants) joining Kerala.
- Andhra Pradesh, West Bengal, Gujarat and Haryana are in closer proximity to achieving the MDG target.

Obstetric causes: These are responsible for the “True Maternal Mortality” and include puerperal sepsis, toxemia of pregnancy (pregnancy induced hypertension), hemorrhages, rupture of uterus and other accidents of labor. They account for more than half the cases of maternal mortality in the world. Other direct causes are ectopic pregnancy, embolism anaesthesia related, obstructed labor and unsafe abortions.

Nonobstetric causes: These include anemia, heart and kidney diseases, malignancies hypertension, diabetes, jaundice, tuberculosis, accidents, etc.

Social causes: These are as follows:

- **Early marriage:** Maternal mortality is high if the age at conception is below 18 and above 30 years. Early marriage is associated with low age at conception.
- **Parity:** About a quarter of deaths occur in primiparous women. The mortality rate is also high after fifth pregnancy.
- **Economic condition:** Overcrowding, undernourishment and, in general, a low standard of living predispose to higher risk of maternal mortality.
- **Illiteracy:** It is conducive to poor management of pregnancy, labor and puerperium and is hence associated with higher maternal mortality.
- **Short birth interval:** This is associated with increased risk of maternal mortality.
- **Lack of antenatal, natal and postnatal care:** Most maternal deaths occur during or shortly after childbirth. Three fourths of these can be prevented by efficient antenatal, natal and postnatal services.

Around 30% of all women need emergency care during delivery. Only 35% of all deliveries are conducted by a doctor. Only 15% are conducted by a nurse, ANM, midwife or Lady Health Visitor. In urban areas more than 69% of the deliveries took place in institutions but in rural areas only 30% took place in institutions (DLHS2).⁷

Global estimates of the causes of maternal deaths 1997–2007⁸

Causes	Percentages
Hemorrhage	35%
Hypertension	18%
Sepsis	8%
Abortion	9%
Embolism	1%
Other direct	11%
Indirect	18%

Major causes of Maternal Mortality in India⁹

Causes	Percentages
Hemorrhage	38%
Sepsis	11%
Abortion	8%
Hypertensive disorders	5%
Obstructed labor	5%
Other conditions	34%

These may be discussed under 3 heads:

CONTROL OF MATERNAL MORBIDITY AND MORTALITY

The government of India has launched in 1992 the Program of Child Survival and Safe Motherhood (CSSM). The Safe Motherhood component of the Program has three elements:

1. Essential obstetric care for all through the primary health care approach
2. Early detection of complications, and
3. Emergency services for those in need.

The CSSM program has now been merged with the RCH program.

“At Risk” Mothers

It is not possible for all pregnant women to be seen by an obstetrician or to be admitted in hospital for delivery. The best possible use of scarce resources can be made only through a planned approach. The WHO⁹ has suggested the use of “risk approach” as a managerial tool for MCH care. The basic idea is to detect pregnant women who are at risk of having a complicated pregnancy, so that they may be referred to a medical officer, an obstetrician or a hospital in time, thus minimising maternal mortality. The suggested criteria for such referral are given in **Table 30.1**.

The risk approach has raised a controversy recently. Some researchers have documented that if anemia, short stature and bad obstetric history are taken into

account, over 90% of India’s pregnant women are at risk. Therefore, this approach does not focus action, and all women should get antenatal care. Besides that, recent studies related to women who died due to pregnancy and child birth revealed that only 50% had one or more risk factors while the remaining 50% had none.¹³ In other words, the probability of a pregnant woman with any risk factor dying due to pregnancy related causes is just as much as in a woman without any risk factor. Further, risk approach for maternal care conveys to the health workers the impression that they cannot render any care to pregnant woman with risks. Attempts to refer such pregnant women to hospitals lead to increased reliance on the traditional birth attendants with its added problems. This underlines the need to provide essential antenatal care for all. This should include check ups for early detection of complications.¹³

Pediatric Morbidity and Mortality

Pediatric Morbidity

The two major causes of morbidity in children are malnutrition and infection. The problem of childhood malnutrition has been described in detail in Chapter 22. The two major infective illnesses in children are acute respiratory infections and diarrhea. Skin infections like boils, furuncles and impetigo, as also conjunctivitis, are fairly common in children, especially in those living in unhygienic conditions. In certain areas, tuberculosis, leprosy and malaria may also be common in children.

Pediatric Mortality

Child deaths (below 15 years age) account for two-thirds of total mortality in India. Half of the pediatric deaths (one-third of the total mortality in the population) occur during infancy while another half occur during the period 1 to 14 years.

Infant mortality has been steadily decreasing in India (**Table 30.2**). This has been possible due to environmental control of communicable diseases, immunization of children, decrease in malnutrition and better availability of health facilities, including MCH care. However, the IMR in India is still much higher than in the developed countries, where it is less than 15.

IMR estimates 2009:⁶

- Every 6th death in the country pertains to an infant.
- IMR in India 50/1000 live births.
- Maximum IMR in Madhya Pradesh (67) and minimum IMR in Kerala (12). Kerala (12) and Tamil Nadu (28) have achieved the MDG target (28 by 2015). Delhi (33), Maharashtra (31) and West Bengal (33) are in close Proximity.

TABLE 30.1: Risk factors in pregnancy for referral¹⁰⁻¹²

Category 1:	<ul style="list-style-type: none"> • Referral to the health center doctor: <ul style="list-style-type: none"> – Previous convulsions outside pregnancy – Excessive hunger, thirst, and increased frequency of urination – Pain during urination – Productive cough for over 3 weeks – Active tuberculosis – Anemia (Hb 50% or less)
Category 2:	<ul style="list-style-type: none"> • Referral to an obstetrician: <ul style="list-style-type: none"> – Age over 35 – More than five previous births – Most recent delivery a stillbirth – Recent neonatal death – Two or more previous miscarriages or stillbirths – Recent birth of more than 4000 g – Hypertension in previous pregnancies – Convulsions during the current pregnancy – Hypertension during the current pregnancy – Malpresentation, e.g. breech, transverse lie – Twins – Hydramnios
Category 3:	<ul style="list-style-type: none"> • Referral for delivery at hospital: <ul style="list-style-type: none"> – Previous birth using forceps or vacuum extractor – Hemorrhage after three or more previous births – Manual removal of the placenta during three or more previous births – Primipara with height less than 150 cm – Primipara aged less than 16 years

TABLE 30.2: Infant mortality rate in India over the years

Years	IMR
1911-1915	204
1916-1920	219
1921-1925	174
1926-1930	178
1931-1935	174
1936-1940	161
1941-1945	161
1946-1950	134
1951-1961	146
1971	129
1981	110
1991	80
1995	74
2009	50

NB—IMR as per SRS was 70 in 1999⁴

- Female infants continue to experience a higher mortality than male infants.

Infant deaths (deaths within first year of life) account for one-third of total deaths in India. Half of all infant deaths are neonatal deaths, i.e. deaths within first four weeks. About 50% of all neonatal deaths occur during the perinatal period, i.e. within seven days of birth. It may be observed that about two-thirds of the under five deaths occur during infancy.

The causes of neonatal mortality may be prenatal and natal. Common causes include asphyxia, birth injuries, congenital malformations and icterus neonatorum in the first week and prematurity, infections, tetanus, and convulsions in the next 3 weeks. Postneonatal mortality covers deaths that occur within first year after the first 4 weeks. The common causes are: infections (diarrheal disease, acute respiratory infections and meningitis) and malnutrition. In contrast to neonatal mortality, there is considerable scope for reduction of postneonatal mortality, because both infections and malnutrition are amenable to preventive measures.

Deaths in the age group 1 to 4 years account for one-fifth of the overall mortality in India. The age group of 1 to 4 years is at a particularly high risk in the developing countries, as indicated by the fact that 1 to 4 years mortality rates in these countries are 30 to 50 times those in Europe and North America. This is particularly significant in view of the fact that, in comparison, the infant mortality rates are only up to 10 times as high.¹⁴

U5MR estimates 2009:⁶

- U5MR denotes number of children (0-4 years) who died before reaching their fifth birthday per 1000 live births.
- U5MR is 64/1000 live births.
- Maximum in Madhya Pradesh (89) and minimum in Kerala (14).

- Kerala (14), Tamil Nadu (33), Maharashtra (36), Delhi (37) and West Bengal (40) have already achieved the MDG target (42 by 2015).

Although child deaths are falling, but it is not quick enough to reach the MDG target.

School age (5 to 14+ years) is probably the healthiest period. This age group forms one-fourth of the population and accounts for about 10% of total deaths. The chances of dying are only 1.2 to 2.8 per thousand, i.e. the lowest age specific mortality in the entire lifespan.

It may be noted that about one-third of all deaths occurring in India are accounted by 1-14 years mortality, and another one-third by infant mortality.

CAUSES OF PEDIATRIC MORTALITY

These may be listed as follows:

Factors Related to the Mother

- Lack of care of the mother during antenatal and natal period.
- Low child rearing capability of the mother, partly due to lack of education and training of the mother in mothercraft.
- Poverty and ignorance of parents.
- Poor health of the mother during pregnancy and lactation.
- Age of mother and parity. Mortality is higher in children of very young and old mothers. It is lowest in first borns and high after 5th order births.
- Unplanned reproduction and lack of proper spacing, i.e. inter-birth interval.

Factors Inherent in the Child

They may be hereditary, (such as congenital defects and Rh-incompatibility) or nonhereditary (such as PEM, anemia).

Factors Related to the Environment

- Physical factors such as overcrowding, unsafe water and food, insanitary disposal of wastes and excreta, all leading to high incidence of communicable diseases.
- Social factors such as neglect of the female child, broken homes, taboos, etc.
- Lack of availability of well-organized MCH services.
- Lack of community participation for child health.

IDENTIFICATION OF CHILDREN “AT RISK”

The risk approach in MCH¹⁰ is applicable to pregnant women as well as to children. The childhood morbidity and mortality can be minimized if children at risk are identified early so that appropriate management may be done in time. The criteria of children at risk are given in **Table 30.3**.

TABLE 30.3: Identification of “at risk” children¹⁵

- Weight below 70% of the reference standard
- No breastfeeding or insufficient breastfeeding
- Failure to gain weight during three successive months
- Twin births
- History of death of two or more siblings before the age of 24 months
- Death of either or both parents
- Birth order 5 or more
- Severe acute infection like measles, whooping cough or diarrhea
- Spacing of children less than 2 years

LOW BIRTH WEIGHT

Internationally, a LBW infant has been defined as one weighing less than 2500 gm or less at birth and the small-for-date (SFD) as one weighing less than 2 SD below the mean weight for a specific gestational period.¹⁶ The mean birth weights of Indian children are lower than those of their western counterparts and usually a birth weight of 2000 gm is used as a cut-off point for providing special care. The LBW group thus includes both preterm and term small-for-date newborns. About 30% newborns in India are in the LBW category. The high incidence of LBW in our country is accounted by a high number of term SFD infants (i.e. children having intrauterine growth retardation). When it comes to mortality statistics, prematurity and LBW together constitute the first most common cause of infant death in urban India whereas it ranks second in the rural population. Goals for 10th plan is to reduce LBW to 10%.

Etiology of LBW

The causes of low birth weight are not very well understood. In one-third to half, the cause may remain unknown. In any case, the causes of LBW are related to the health of the mother:

- *Factors affecting the general health of the mother*— These include malnutrition, anemia, tuberculosis and other infective and systemic diseases.
- *Factors affecting antenatal health of the mother*— These include pre-eclamptic toxemia, urinary infection; hypertension, multiple pregnancy, etc. Heavy infection of the placenta with malarial parasite can cause LBW in malarious areas.¹⁷

Prevention of LBW

- *Direct interventions*: These include nutritional supplementation, control of infections (including, besides others, malaria, syphilis, toxoplasmosis, rubella, cytomegalovirus, etc.) and early diagnosis and treatment of conditions like diabetes, hypertension and toxemia. Nutritional supplementation has been shown to result in increased birth weight.¹⁸ However, it has been estimated that the average

increase in birth weight as a result of nutritional supplementation during pregnancy in poor communities is only 30 to 60 gm.¹⁹

- *Indirect interventions*: These include antenatal care, family planning and general improvement in socioeconomic conditions. Good antenatal care by itself can bring about 10 to 15% reduction in incidence of LBW.¹⁷ Family planning helps by delaying the age at conception, reducing parity and preventing too short birth interval.

Maternal and Child Health Services

According to WHO, the MCH Services should ensure that:

‘Every child, wherever possible, lives and grows up in a family unit, with love and security, in healthy surroundings, receives adequate nourishment, health supervision, and efficient medical attention, and is taught the elements of healthy living.’

‘Every expectant and nursing mother maintains good health, learns the art of child care, has a normal delivery, and bears healthy children.’ Maternity care, in the narrower sense, consists in the care of the pregnant women, safe delivery, postnatal care, care of her newly born infant, and the maintenance of lactation. In the wider sense, it begins much earlier in the measures aimed to promote the health and well-being of the young, who are potential parents, and to help them to develop the right approach to family life and to the place of the family in the community. It should also include guidance in parent-craft and in problems associated with infertility and family planning.²⁰

Most MCH problems are public health and community problems that can be solved by applying general health measures. Recognition of MCH as a separate entity is desirable in order to focus concern on the special needs of mothers and children due to:

- Biological demands of reproduction, growth and development
- Their vulnerability to diseases as a result of these demands.²¹

MCH services should, therefore, be developed as a special service within the framework, or as an integral part, of the general health services, as is being done in the Primary Health Centers. The MCH services cannot be divorced from the other general health services.

Components of MCH Care

SERVICES FOR THE MOTHER

- Preconceptional
- Antenatal or prenatal care
- Natal care
- Postnatal care
- Family planning.

SERVICES FOR THE CHILD

- Infant care
- Preschool or toddler care
- School health service
- Care of the handicapped.

Services for the Mother

PRECONCEPTIONAL

These services start before the child is conceived. They rather start before marriage or even before the mother reaches physiological maturity. There are three aspects:

Educational

The boys and girls at high school or in college have to be imparted knowledge about hygiene of genitals, physiology of reproduction, HIV/AIDs and dangers of venereal diseases. They should also be given education about planned parenthood, family welfare and mothercraft.

Informational

Benefits of medical supervision during maternity and infancy and facilities available for the same should be made adequately known to married women, even before they conceive.

Eugenics

Eugenics refers to improvement of the genetic stock of the race. Eugenic aspects of services to the mother include prevention of births of children with serious genetic disease, e.g. Down's syndrome, muscular dystrophies, hemophilia, etc. This may be achieved through nonterminal or terminal methods of contraception or through medical termination of pregnancy.

ANTENATAL CARE

An antenatal care should have contact with the health facility as early as possible. This could be either at home or in the clinic once a month in the first 7 months, twice a month during the eighth month and weekly in the 9th month. Under the antenatal program, each registered antenatal case is expected to receive a minimum of 4 physical examinations, of which at least one is to take place at more than 36 weeks gestation. Each antenatal case is also expected to receive at least one home visit prior to delivery.

Components of Antenatal Checkups²²

Antenatal Measurements/Tests (Figs 30.1 to 30.3)

- Weight measured
- Height measured

- Blood pressure checked
- Blood tested – Hb, blood group, Rh factor, VDRL test
- Urine tested – albumin, sugar
- Abdomen examined
- Breast examined
- Sonogram/Ultrasound done
- Delivery date told
- Delivery advice given
- Nutrition advice given.



Fig. 30.1: Urine pregnancy test card.



Fig. 30.2: Urine Reagent stripes for urinalysis.



Fig. 30.3: Digital sphygmomanometer.

Antenatal Counseling for Danger Signs

- Weight measured
- Height measured
- Vaginal bleeding
- Convulsions
- Prolonged labor
- Swelling of feet
- Blurring of vision
- Any unusual symptoms.

Antenatal Advice

- Counseling for IFA tablets
- Counseling for TT injections – 2 doses
- Breastfeeding
- Keeping the baby warm
- Need for cleanliness at the time of delivery
- Family planning advice
- Better nutrition for mother and child
- Need for institutional delivery
- Advice to use iodized salt.

Janani Suraksha Yojana (JSY) is one of the important programs under the overall umbrella of NRHM. The main objective of JSY is to reduce maternal mortality ratio and infant mortality rate. To achieve this, cash assistance is given to the pregnant woman to enable her to make all the required antenatal care visits, and avail of institutional care during delivery and immediate postpartum period in a health center. A system of coordinated care by field level health worker namely ASHA/AWW and ANM has been established.²²

NATAL CARE

These services include management of labor at home, or at the health facility where the woman is registered during antenatal period. The *objectives* of good natal care services are:

- Conduction of delivery in thoroughly aseptic conditions (It is good to remember 5C's for a clean delivery; clean hands, clean surface, clean razor blade, clean cord tie and clean cord stump). For maintenance of 5c. Disposable delivery kit (DDK) has been provided to mothers. DDK contains—clean blade, clean cord tie, soap, gauze and mackintosh (**Fig. 30.4**).
- Delivery with minimum injury to the infant and mother.
- Prevention, early detection and management of complications of labor.
- Care of the newborn baby.

For prevention of hypothermia, Hypothermia kit has been provided to mothers after birth, that includes nine elements like, nets, socks, cap gloves, baby cloths, one saree for the mother, etc.

Most of the deliveries can be safely conducted at home. About 1% of deliveries tend to be abnormal

and about 4% are difficult, requiring the services of a doctor. Delivery at the maternity homes is often preferred by people for the sake of comfort, convenience and availability of medical aid. However, home delivery has its own advantages because the mother is still able to a certain extent to take care of the other children and to supervise the household. For the present, most of the deliveries are conducted at home through trained staff or untrained indigenous *dais*. *Institutional deliveries in rural areas* may be restricted to:

- Elderly primiparae and multiparae beyond fifth pregnancy.
- Difficult labor, as in case of contracted pelvis.
- Mothers with complications such as pre-eclamptic toxemia, malpresentation, antepartum hemorrhage, etc.
- Antenatal cases requiring hospitalization due to any reason.
- Mothers whose homes are not suitable for delivery due to physical, social or emotional reasons.

POSTNATAL CARE

Each postnatal case is visited thrice during puerperium. On these visits the cord is dressed, the mother is examined for fever and retention of milk and advice is given about infant feeding and care of the breasts. More visits are paid during puerperium if the case is complicated. Monthly visits should than be paid at the end of the first, second and third month after delivery. Thereafter, the mother should be asked to report at the health center at the end of fourth, fifth, seventh, ninth and twelfth month.

Breastfeeding

Breast milk is the most suitable, economic, nutritious, sterile and specific food for infants and possesses anti-infective property. The initial breast milk is called colostrum. It is very rich in antibodies and must be given to the newborn. Breast milk can constitute a complete diet for a child during 0 to 6 months of age. Secretion



Fig. 30.4: Disposable delivery kit (DDK)

TABLE 30.4: Criteria that define selected infant feeding practices

Feeding practice	Requires that the infant receive	Allows the infant to receive	Does not allow the infant to receive
Exclusive breastfeeding	Breast milk (including milk expressed or from a wet nurse)	ORS, drops, syrups (vitamins, minerals, medicines)	Anything else
Predominant breastfeeding	Breast milk (including milk expressed or from a wet nurse) as the predominant source of nourishment minerals, medicines)	Certain liquids (water and water-based drinks, fruit juice), ritual fluids and ORS, drops or syrups (vitamins,	Anything else (in particular non-human milk, food based fluids)
Complementary Feeding	Breast milk (including milk expressed or from a wet nurse) and solid or semisolid foods	Any food or liquid including non-human milk	
Mixed Feeding	Breast feeding Including non-human Milk	Any food or drink	
Bottle feeding	Any liquid or semi-solid food from a bottle with nipple / teat breast milk by bottle	Any food or liquid including non-human milk. Also allows	

Source: Indicators for assessing infant and young child feeding practices. Part 1. Definitions
Conclusions of a consensus meeting held 6–8 November 2007 in Washington, DC, USA.

of breast milk depends upon age, nutrition and mental status of the mother. On an average, an Indian mother secretes 600 ml of breast milk per day with 1.2 g% protein in the first year of lactation. 100 ml breast milk gives 71 kilocalories. Breast feeding should be initiated as early as possible preferably within ½ hours of birth in normal delivery and within 4 hours in Cesarean section. The mother should be encouraged to breast feed the child up to 2 years or more if baby wishes. Also, different criteria for the infant feeding are listed in **Table 30.4**.

Advantages of Breastfeeding

- To baby:
 - Anti-infective properties.
 - Easily digestible and meet all the nutritional need for growth and development.
 - Protect against allergic reaction and future development of coronary heart disease.
 - Nurture bonding between mother and baby.
 - Reduce the incidence of dental caries.
 - Breast fed babies have a higher IQ and have less chance to develop hypertension, obesity, CHD, DM in later years.
- To mother:
 - Reduce postpartum hemorrhage and help early postpartum uterine involution.
 - Lower the risk of breast and ovarian cancer.
 - This mode of feeding is more convenient for the mother.
- To family and society:
 - Economical.
 - Help delaying child birth.
 - Do not causes environmental pollution.

Adequacy of Breast Milk

If the following conditions are met, then breast milk is adequate.

- Baby is gaining weight, as documented by growth chart at periodic intervals.
- Baby is feeding and sleeping well.
- Baby urinates about six times a day.

Complimentary Feeding

Gradual introduction of semisolid foods to the infants at the age of 6 months of age in addition to usual breast-feeding is known as complimentary feeding.

The ideal time to introduce semisolid feeds to babies is about 6 months of age, because of the following reasons:

- Baby needs food and water in addition to breast milk for further development, since activity of the baby increases. Baby has good appetite and accepts food readily.
- Baby's stomach is ready to digest outside food in addition to breast milk.
- After the age of 6 months of the baby, milk secretion is also gradually decreased.

Desirable quality of foods to be introduced in complimentary feeding:

- High energy density
- Easily digestible
- Semisolid consistency
- Low in bulk and viscosity
- Fresh, clean and easy to prepare
- Should be affordable, available and culturally acceptable

Introduction of Semisolids

From the age of 6 months onwards, semisolid forms of locally available foods should be introduced along with milk. Solid substances such as cereals (roasted and cooked), dais (well cooked), ripe bananas, fruits, boiled potatoes, soft cooked rice, etc. should be mashed well before feeding. Cereal gruel cooked with milk may be started at 6th month. Egg yolk with milk may be started even earlier. At the end of 6 months, gruel, rice porridge, biscuits, mashed potatoes, mashed vegetables, minced meat, etc. can be introduced. Curd may be mixed with these feeds instead of milk. Also, the soft and spongy idli in the south and dhokla in Gujarat can be mashed with milk. At the age of one year, the baby may eat solid foods freely but a major part of diet should still be milk. 500 ml of milk should be taken every day, preferably till adolescent age. While introducing solid foods, the following general precautions should be observed:

- Start one supplementary food at a time in small quantities.
- Go on increasing the quantity and frequency of the supplement.
- As the child tolerates and develops liking for these, gradually add other articles of diet in the same manner.
- Encourage the use of mixtures of cheap locally available vegetable proteins in judicious combination. Thus eating wheat and pulses together provides better quality of proteins than eating them separately. Similarly, pulses and rice, if taken together, will increase the protein value of food.

Signs of good positioning of baby during breast-feeding:

- Position of the baby's head and body in straight line.
- Baby's head and body facing breast.
- Infant's body is close to the mother's body.
- Support to the infants whole body by the mother.

Signs of good attachment of baby during breast-feeding:

- Chin touching the breast.
- The mouth is wide open.
- The lower lip is turned outward.
- More areola is visible above the mouth of the baby.

Baby Friendly Hospital Initiative (BFHI)

Baby Friendly Hospital Initiative was launched in 1992 as part of the 'Innocenti Declaration' on promotion, protection and support of breastfeeding. Baby friendly hospitals are required to adopt a breast feeding policy and conform to its ten steps for successful implementation of breast-feeding.

The ten steps of BFHI

1. Have written breastfeeding policy that is routinely communicated to all health care staff.

2. Train all health care staff with necessary skill to implement the policy.
3. Inform all pregnant woman about the benefit and management of breast feeding.
4. Help to initiate breastfeeding with in half an hour of delivery.
5. Show mother how to breastfeed and maintain lactation even if they should be separated from their infants.
6. Give new born infants no food or drink other than breast milk unless medically indicated.
7. Encourage breastfeeding on demand.
8. Practice rooming-in – allow mothers and infants to remain together – 24 hours a day.
9. Give no artificial teat or pacifier to breastfeeding infants.
10. Foster the establishment of breast feeding support group and refer mothers to them on discharge from the hospital or clinic.

The Infant Milk Substitute, Feeding Bottles and Infant Foods Act 1992

Government of India has made effort for regulation of production, supply and distribution of infant milk substitutes. The act prohibits advertising of infant milk substitutes and feeding bottles to public.

Salient features:

- *Promotion to public:* No person shall advertise, promote, offer incentive for promotion of sales of infants milk substitute (IMS).
- *Labeling:* Should contain specified information, no picture of infant or woman, not to use word like approved by "medical professions"/ humanized / complete food, etc.
- *Promotion to health care:* No display of posters/ placards on IMS in hospitals, no incentives, gifts to health care worker for promotion of IMS, feeding bottle, infant foods.

Provision of penalty: Violation of the act may lead to fine and or imprisonment up to 3 years.

FAMILY PLANNING

This is an important component of MCH services. The mother is more receptive to family planning advice during pregnancy. Also, tubal ligation can be easily performed soon after delivery, when the size of the uterus is still large. These are only some of the reasons why family planning can be usefully linked with MCH. In view of this linkage, the government has put into operation an All India Hospital Postpartum Program.²³ Details about this program are given in the next Chapter. Every postnatal case should be advised about a suitable method of family planning.

Services for the Child

Service for the school age child (5 to 14 years) are described under School Health Program in Chapter 32. Only the services for the preschool child will be described here. These will be discussed as per the five levels of prevention, viz. health promotion, specific protection, early diagnosis and treatment, disability limitation and rehabilitation.

HEALTH PROMOTION

This is basically achieved through health education to the mother as follows:

- Guidance and demonstration on various aspects of baby care, such as toilet training, bathing and dressing the baby.
- Information about milestones in growth and development, such as lifting of head, walking, talking and cutting of teeth, etc.
- Education regarding infant and child feeding, including breastfeeding.
- Convincing the mother about the need for immunization and family planning.
- Mothercraft classes on various aspects of child care.

Growth Monitoring

Growth monitoring means keeping a regular track of the growth and development of the child with the help of key nutrition indicators related to their age like weight and height.

Growth monitoring is a useful tool for the following reasons:

- To detect early growth faltering and prevent under nutrition.
- To identify underweight children who need special care and feeding at home.
- To identify severely underweight children who need special care and feeding at home and referral advice.
- To find out different causes of weight loss, i.e. illness like diarrhea, ARI, etc.
- To educate, counsel and support mothers and families for optimal nutrition, health care and development of their children.

Growth Chart

Growth charts are important tools in the assessment of growth and nutritional status for clinical use (individual children) as well as epidemiological use (groups of children). Although many countries have national growth charts, a great many do not. For use in such countries, and also for international comparisons, the World Health Organization (WHO) adopted growth charts which had been constructed by the National Center for Health Statistics (NCHS) of the United States of America in 1978, known as NCHS/WHO growth charts.

Limitation of Early NCHS/WHO Growth Chart

But this chart was not representing the growth of infants very faithfully. In comparison with the weight of breastfed infants in Europe and the United States, the weight for age of the NCHS/WHO charts was shown to be unduly low in the first 6 months of life, whereas in the second 6 months NCHS weight tended to be higher than that of breastfed infants. These shortcomings were thought to be due to anthropometric data during the first year of life were spaced too widely (every 3 months). Secondly, few of the infants were fully breastfed, and of those who were breastfed many were breastfed for only a short period.

Other Growth Charts

The NCHS 1977 Growth Curves: This was based on longitudinal data from birth to 3 years collected by the Fels Institute between 1929 and 1975.

The CDC 2000 Charts: This chart is a modification of the NCHS chart, was prepared by cross-sectional data from birth to 3 years from 5 nationally representative surveys conducted in the US between 1963 and 1994.

Euro-Growth 2000 Charts: Data were collected from subjects born between 1990 and 1993 were followed longitudinally from birth to 5 years.

New WHO Growth Standards

To overcome different shortcomings of early NCHS/WHO growth chart, a multicentre growth reference study was carried out between 1997 and 2003 at 6 sites in 6 countries (Brazil, Ghana, India, Norway, Oman, USA) with the objective of describing the growth of children living under conditions that posed no constraints on growth. The study consisted of two parts, a longitudinal study in which subjects were followed from birth to 2 years of age, and a cross-sectional study of children between 1.5 and 5 years of age. It is worth noting that, as all other charts, the WHO charts from birth to 2 years represent recumbent length and only from 2 years on do they represent standing height. The new WHO Growth Standards for global use were released in 2006.

Characteristics of New WHO Growth Standards

The new WHO growth standards differ from other growth charts in a number of ways. Because of the many differences, only a few general statements can be made.

- During the first 6 months of life, WHO weight and length at all percentiles are larger than weight and length by any other chart.
- During the second 6 months of life, and continuing through the 2nd year of life, WHO weight (but not length) is lower than weight by other charts.

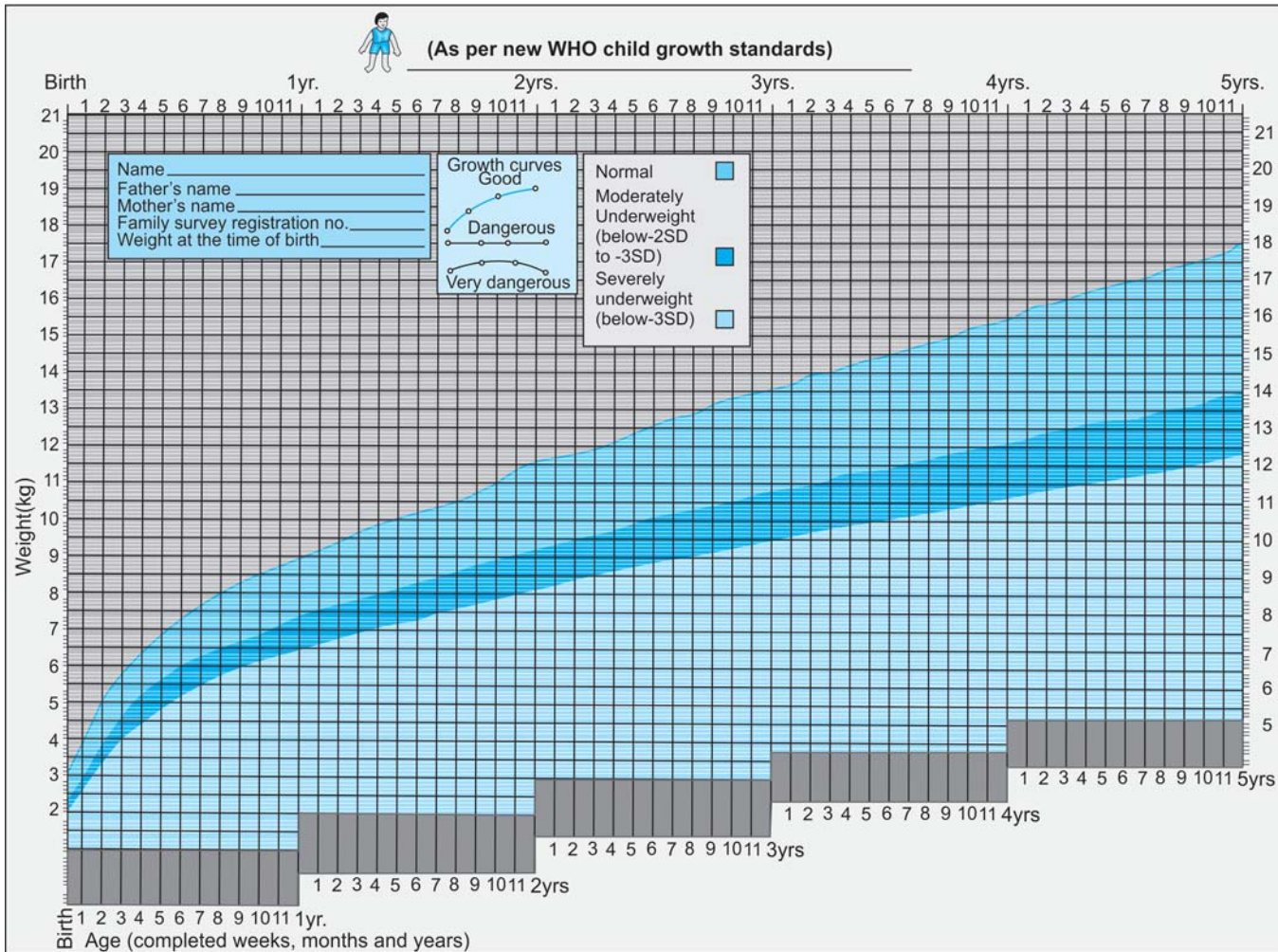


Fig. 30.5: Boy: Weight-for-age—birth to 5 year

- Between 2 and 5 years of age, WHO weight tends to be at the lower end of the spectrum, especially at the lower percentiles, whereas Euro-Growth occupies the top end for weight at all percentiles.
- Functional assessment shows that the WHO charts identify fewer 1- to 2-year-old as underweight and more 2- to 5-year-old as overweight than other charts.

NEW ICDS GROWTH CHART

Presently in ICDS, growth monitoring is done with the help of growth charts, separate for girls and boys, using weight-for-age index, which is based on new WHO Child Growth Standards (2006). Growth chart is used to identify normal growth as well as early growth faltering of a given child.

Pink border growth chart is for girls and blue border chart is for boys. Each growth chart has two axes. The horizontal line at the bottom of the chart is the X axis, which is for recording the age of the child for five years and is also known as ‘month axis’. The vertical line at the far left of the chart is the Y axis – meant for recording the weight of the child from birth onwards and is called ‘weight axis’.

The month axis of each growth chart has five boxes, representing five years. Each box contains 12 small squares representing 12 months, i.e. each small square on month axis represents 1 month. Overall, month axis of each growth chart has 60 squares and can be used for a child for 5 years or 60 months. White rectangles below the month axis are for writing months and years as per the date of birth of the child. Age is recorded in completed weeks/months/years. It is recorded in completed weeks only for a child below 1 month. Similarly on weight axis, lines are marked for recording weight in kilograms and grams. Each thick extended line represents 1 kg, each line extended from a small square represents 500 gm. And the very thin line represents 100 gm.

On each growth chart, there are 3 preprinted growth curves. These are called reference lines or Z score lines and are used to compare and interpret the growth pattern of the child and assess the baby’s nutritional status. The first top curve line on the growth chart is the median which is generally speaking, the average. The other two curve lines are below the average and are at a distance. Weight of all normal and healthy children, plotted on the growth chart, fall above 2nd curve (dark green band); weight of moderately underweight children fall below the 2nd curve to 3rd curve (yellow band); and

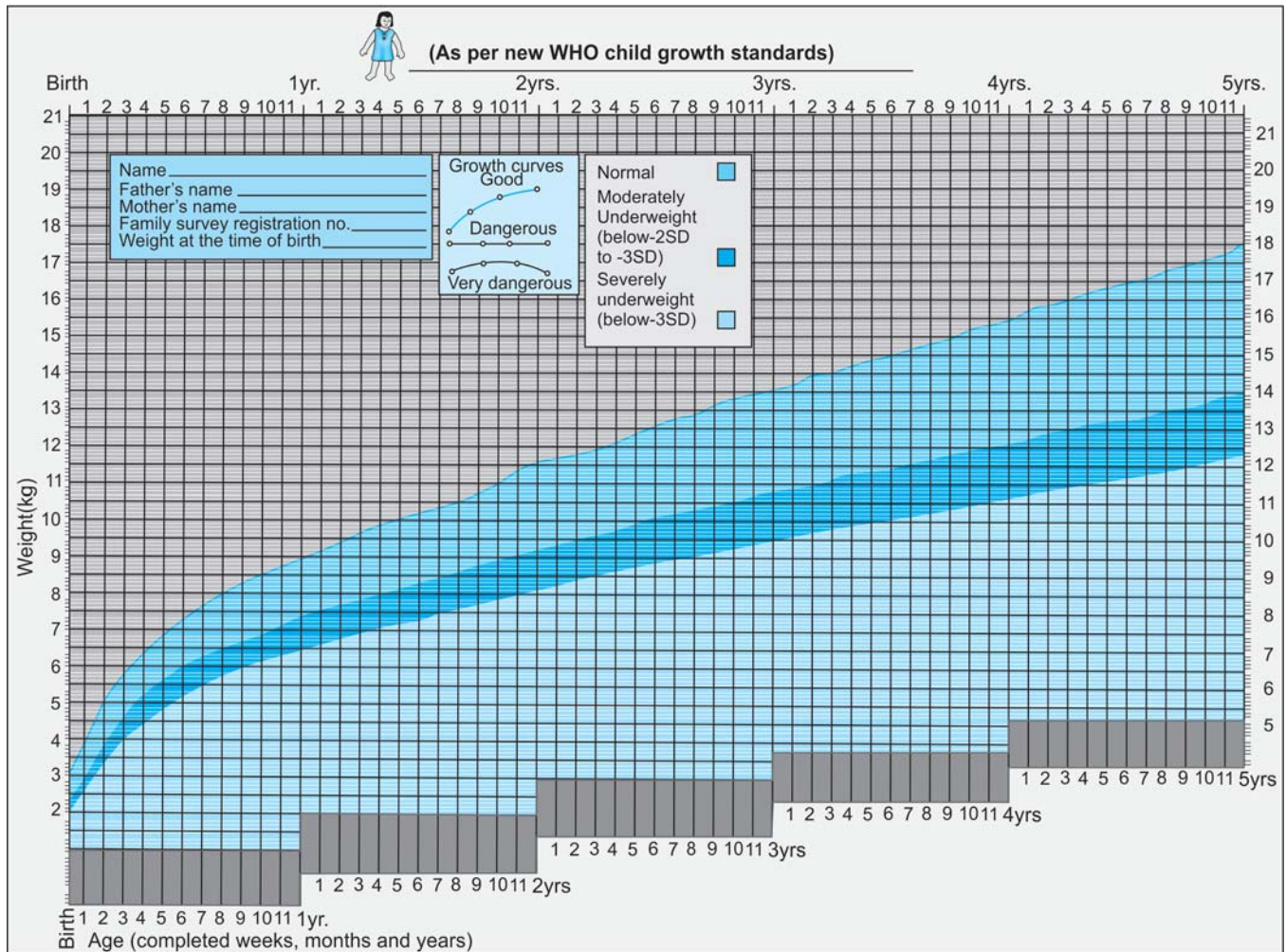


Fig. 30.6: Girl: Weight-for-age—birth to 5 year

weight of severely underweight children fall below the 3rd curve (orange band).

One information box has also been provided on the upper left hand side of each growth chart. Name of the child, father's name, mother's name, registration number and birth weight has to be written in this box.

A point on a growth chart, where a line extended from a measurement on the month axis, i.e. age, intersects with a line extended from a measurement on the weight axis, i.e. weight, is called a plotted point. A growth curve is formed by joining the plotted points on a growth chart. Direction of the growth curve is more important rather than a single plotted point. From direction of the curve it will be evident whether a child is growing or not.

Justification of New WHO Child Growth Standards in ICDS

- Earlier, the Indian Academy of Paediatrics used rightly Harvard Standards based on the experience of the growth of Indian children by using percentage rather than percentile.
- The growth of the children now over a period of three decades through ICDS has shown that the

earlier standards are no more applicable for Indian children.

- Exclusive breastfeeding for first 6 months of life is now the recommendation.

Rationale Behind the Adoption of New WHO Child Growth Standards in ICDS

- Earlier standards were based on infants receiving bottle and mixed feeding. New standards have been developed on infants exclusively breastfed for 6 months.
- We must know how children should grow, rather how they are growing.
- Children below six years have same potential to grow and develop as long as their basic needs of nutrition, environment and health are met.
- Previous chart was unisex. But new charts are separate for boys and girls, since boys and girls grow differently.

STEPS OF GROWTH MONITORING

The following are the five steps of growth monitoring (Figs 30.5 and 30.6):

TABLE 30.5: Growth chart of recorded age of the child

Age of the child	Recording of age
Child is less than 1-month-old	Age is recorded in completed weeks
Child between 1 month and 1 year	Age is recorded in completed months
Child more than 1 year	Age is recorded in completed years and months

- Assessment of correct age of the child in completed weeks or months or years and months.
- Measurement of weight of the child to the nearest 100 grams.
- Plotting the weight accurately on the growth chart.
- Interpretation of the plotted point and the direction of the growth curve.
- Discussion of the child's growth with the mother and the family followed by counseling and follow-up.

Correct age of the child is assessed from birth certificate, local events calendar, etc. Age is recorded in the growth chart as follows (**Table 30.5**).

Then weight of the child is plotted to the nearest 100 grams on his/her growth chart by using salter weighing scale. According to age, a dot is plotted on the vertical line of the identified month box. For example, if a child is 8½ months old, the point will be plotted on the line for completed months, i.e. 8 months and not between the lines for 8 and months. This dot is extended on the vertical line on the month axis upwards to plot weight-for-age. Similarly a dot is placed on the horizontal line which shows weight measurement. Then this dot is extended on the horizontal weight measurement line on the weight axis towards right to the point where it intersects with the line which is extended from the vertical line from the month box indicating the present age of the child. A dot is placed on the line where the two lines intersect. A circle is drawn around the dot, so as to know the position of the plotted weight for weight-for-age. Position of the plotted weight is noted with reference to preprinted growth curves.

Interpretation of the position of the plotted point on the growth chart:

- If the plotted weight falls much above the first curve, the child has a growth problem, which can be overweight or obesity.
- If plotted weight falls exactly on the first or second or third preprinted growth curve line, then the child is in the less severe category of undernutrition, e.g. plotted point on the 2nd curve line indicates that the child's growth is normal and s/he is not moderately underweight, whereas the plotted point below the 2nd curve line indicates that the child is moderately underweight.
- If plotted weight for age of a child falls on the green band, then the child's growth is normal; if it falls on the yellow band, child is moderately underweight and if the plotted weight is on the orange band, the child is severely underweight.

Assessment of the nutritional status of the child as per the plotted weight-for-age (Table 30.7):

If the child's growth curve crosses a pre printed curve—either from above or below, it means there has been a significant change in the child's growth. This may indicate a good change or risk. If the shift is toward the 1st curve (green), this is probably a good change. If the child's growth curve line stays close to the 1st curve, occasionally crossing above and below it, this is also fine. But if the shift is towards to 2nd curve (yellow) or 3rd curve (orange) this indicates a problem or risk of a problem. If this shift is noticed in time, it may be possible to intervene early and prevent further downward progression.

HEALTH PROTECTION

Immunizations should be performed according to the universal Immunization Program as described later. The mother should be cautioned about domestic and street accidents to which the child is exposed.

INTERPRETATION OF DIRECTION OF CHILD'S GROWTH CURVE (TABLE 30.6)

TABLE 30.6: Direction of child's growth curve

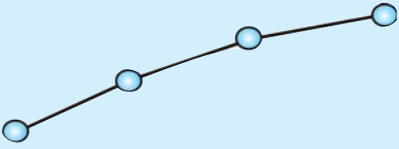
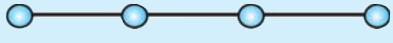

Direction of growth curves	Interpretation of growth pattern	Diagrammatic representation
Upward growth curve	Growth pattern is Good; indicates adequate weight gain for the age of the child. The child is growing well and is healthy	
Flat growth curve	Growth pattern is dangerous; indicates child is not growing adequately and is not gaining weight, known as stagnation. This child needs attention and investigations are required.	
Downward growth curve	Growth pattern is very dangerous; indicates loss of weight and the child needs immediate referral and health care.	

TABLE 30.7: Nutritional states of the child as per the plotted weight-for-age

Position of the plotted point status	Interpretation of nutritional status
Exactly on or above the 1st curve Between the 1st and 2nd curve Exactly on the 2nd curve	Child's growth is normal
Between 2nd and 3rd curve Exactly on the 3rd curve	Child is moderately underweight
Below the 3rd curve	Child is severely underweight

EARLY DIAGNOSIS AND PROMPT TREATMENT

The health staff should look for any deviation from the normal at the earliest, right from the birth, and should treat the defect or report the same to doctor as explained below:

- If the baby does not breathe or cry after birth, the midwife should clear the mucus from the airway.
- If the child is premature, she should arrange for expert rearing, or transfer him to a premature baby clinic.
- Cephalhematoma, systolic murmur, engorgement of baby's breasts, jaundice, abnormalities of stool and delayed healing of cord should be promptly reported to the doctor.
- Height, weight and head circumference should be recorded. Liver and spleen should be palpated and other parts of the body examined for any swelling or congenital defect.
- Genitals should be examined for phimosis, discharge and congenital abnormalities.
- Physical or mental handicaps, if any, should be reported to the medical officer and the specialists.

DISABILITY LIMITATION

This is especially important in case of children who have developed poliomyelitis or rheumatic fever.

REHABILITATION

This is particularly needed for children who are deaf-mute, physically handicapped (polio, congenital defects, etc.) blind or mentally retarded.

UNDER-FIVES CLINIC

In recent times, the "Well Baby Clinics" are giving way to the concept of the under-fives clinics. The well baby clinics were entirely restricted to preventive pediatrics. On the other hand, the under-fives clinics aim to provide preventive, promotive, curative and rehabilitative health care services to the under five children. In fact, the symbol for under-fives clinics in India depicts these aspects clearly (**Fig. 30.7**). In the case of so-called well baby clinics, there is a risk that those running the clinic may concentrate too much on

routine health check-up of children. This danger is clearly expressed by Jelliffe as follows: "Well baby clinics that are expected to function on their own-are generally expensive failures. They may develop a hollow routine of weights, measures and immunisations unless they work in close cooperation with hospitals and follow-up properly those who are sick or at risk. The ideal should be a 'child welfare clinic' rendering both preventive and curative services and not to have a 'well baby clinic' for the well and a separate children's clinic for the sick. In a teaching hospital such a clinic should demonstrate integrated pediatric practice.²⁵ It is in view of this that the term 'under-fives clinic' is preferable to well baby clinic.

The fact that 50% of total deaths in India occur in under-fives children points to the need for special attention towards this age group. This need is sought to be fulfilled by under-fives clinics, the functions of which are enumerated below.

Functions of Under-fives Clinic

- Registration of all infants and toddlers and preparation of a specific card.
- Medical check-up on scheduled visits, at least once by medical officer and on other occasions by the MCH staff.
- Regular recording of health data such as height, weight, etc. to verify normal growth and development.
- Distribution of nutritional supplements (supplementary food, vitamin A and iron-folic acid tablets or solution).
- Immunization.
- Reporting of all registered children to the health assistant so that he may check and update his vital statistics records.
- Early detection of any communicable and non-communicable disease or congenital defect.
- Prompt treatment of diseases and defects.
- Referral to specialists.
- Training to mothers regarding child feeding and other aspects of mothercraft.
- Advice about family planning.
- Health education by arranging health exhibitions and well baby competitions.

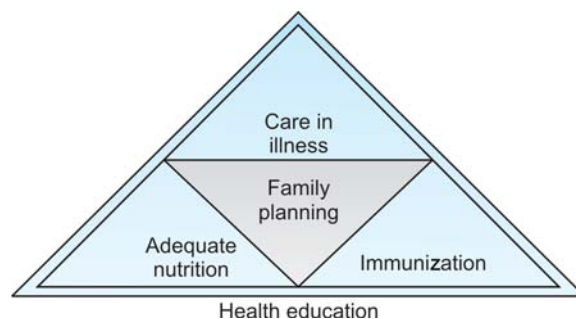


Fig. 30.7: Symbol for under-fives clinic. (Note that health education encompasses all four components in the triangle)

OTHER WELFARE SERVICES REQUIRED FOR CHILDREN

Creches (Day Care Centers)

They are compulsory for factories under the Factories Act, 1948, if more than 50 women are employed. It is worthwhile having such creches or nurseries in towns and big Gram Panchayats. A woman worker, qualified as a health visitor, nurse-midwife or public health nurse, is required to look after the children. A doctor should be available on call.

Care of the Handicapped

- For the mentally handicapped, there should be child guidance clinics, as also schools and homes for the mentally retarded.
- For the physically handicapped children, such as the deaf, dumb, blind, spastic and paralysed, there are special institutions, such as the All India Institute of Physical Medicine and Rehabilitation, Mumbai, Spastics Society of India, Mumbai and Delhi, Occupational Therapy School, Nagpur, etc. The Ali Yavar Jung Institute for the Hearing Handicapped, with headquarters at Mumbai and regional centers at Kolkata, Hyderabad, New Delhi and Bhubaneswar, was established in 1982 and provides integrated services at national level for education, training and research for the hearing handicapped. There are at present 300 schools for the deaf in India.
- For psychosocially handicapped children (children who are orphans, who suffer from maternal deprivation, who come from separated homes, etc.), there is need of orphanages, foster homes, etc. as also for a proper mechanism for legal adoption by adoptive parents.

Child Rights and Policy

The Parliament approved the National Policy for Children on Aug 22, 1974. The Integrated Child Development Services Scheme launched in 1975. The major child issues which need urgent attention are child labor and primary education. These two are, in fact, interlinked. One of the main deterrents in achieving the goal of Education for All by 2000 has been the large child work force, the estimate for which varies from 11 to 44 million. While female literacy is especially crucial for national development, it is tragic to note that only a third of girls aged 5 to 11 years go to school in India. Abolition of child labor is one of the basic components of the Convention on the Rights of the Child, which was ratified by India in 1992.

National Programs for Maternal and Child Health

There are five national programs that are carried out as part of MCH program:

1. Prophylaxis against nutritional anemia in mothers and children: Described in Chapter 22.
2. National Diarrheal Diseases Control and ORT Program: Described in Chapter 17.
3. Prophylaxis against blindness due to vitamin A deficiency among children: Described in Chapter 22.
4. Control of acute respiratory infections: Described in Chapter 16.
5. Universal immunization program (UIP), described in this Chapter.

As the objectives of all these programs were convergent, during the VIII Plan, these programs were integrated under Child Survival and Safe Motherhood Program which was implemented from 1992-93. This process of integration of related programs was taken a step further in 1994 when the International Conference on Population and Development in Cairo recommended that the participant countries should implement unified programs for Reproductive and Child Health. Accordingly, the CSSM and related programs have been reorganized into RCH package of programs by adding components on sexually transmitted diseases (STDs) and reproductive tract infections (RTIs). This project is supported by World Bank, European Community, UNICEF, DANIDA, ODA and UNFPA.²⁷ It may be mentioned that the Integrated Child Development Services (ICDS), a national program of the Ministry of Human Resource Development, is also essentially an MCH program.

Reproductive and Child Health (RCH) Program

The National Child Survival and Safe Motherhood Program was formally launched in 1992 to meet the total health needs of both the mother and the child. This was replaced by the RCH program in 1994. RCH program was formally launched by Government of India in October 1997. There was a paradigm shift from target oriented to Target Free Approach (TFA). RCH program covered the services provided under the CSSM and Family Welfare Program, which were merged as well as two new interventions, viz. management of RTIs and STIs and adolescent reproductive health.²⁶

The program aims at achieving a status in which people will be able to regulate their fertility, women will be able to go through their pregnancy and child birth safely, the outcome of pregnancies will lead to well being and survival of the mother as well as of the child and couples will be able to have sexual relation free of fear of pregnancy and of contracting sexually transmitted diseases. Here life cycle approach has been adopted.

The RCH concept consists of providing to the beneficiaries need-based, client-centered, demand-driven and high quality integrated services.

In order to ensure provision of quality services, the RCH program strategy includes:

- Community Need Assessment (CNA) and subcenter planning for ensuring need-based, client-specific and demand driven services.
- Adequate management of these RCH services at each level.
- Training has been included for improving task performance and competence of the service providers.

Community need assessment (CNA) concept means that, these would be based on the actual needs of the people and not on the needs as perceived by the top level professionals and administrators. Its focus starts with the young married girls and continues through pregnancy, child birth and care of newborn babies to include the older children. The entire Mother and Child Health Program, including various components like Immunization, Anemia Prophylaxis, Prophylaxis against vitamin A deficiency, Oral Rehydration Therapy, Acute Respiratory Infections control and Birth spacing has been integrated to meet the requirements of beneficiaries in health as well as disease. The program is envisaged to be implemented within the existing primary health care infrastructure through the multipurpose health worker, with the assistance of village local workers like Anganwadi Workers, Village Health Guides and Trained Birth Attendants.²⁷

Reproductive and child health (RCH) phase II was launched on 1st April 2005, in order to address some limitations of RCH phase I.

Components

The components of the program to be delivered as a package would be:

For Newborn and Children

- Skilled care at birth
- Integrated Management of Neonatal and Childhood Illness (IMNCI) for common childhood illness
- Newborn care at home—Warmth and feeding.
- Primary immunization by 12 months—100% coverage.
- Vitamin A prophylaxis (9 months to 3 years)—100% coverage.
- Pneumonia—Correct case management at home or health facilities.
- Diarrhea—Correct case management at home or health facility: ORS in every village.

ESSENTIAL NEWBORN CARE

Essential newborn care: It comprises of resuscitation at birth for prevention of birth asphyxia, initiation of breast feeding within half an hour of birth, rooming in,

keeping the baby warm, no bathing at birth, prevention of infection and immunization.

Improvement in Child Health and Survival are important aspects of the program. Prematurity, acute respiratory infections, diarrhea, anemia, neonatal tetanus and birth injuries account for approximately 70% of all infant deaths. State Governments are being advised to give focused attention to antenatal care and nutrition of pregnant mothers, essential newborn care to prevent early neonatal deaths, control of deaths due to diarrhea and acute respiratory infections and prophylaxis against Vitamin A and Iron deficiency anemia apart from the Immunization Program.

Neonatal care is a thrust area under RCH program. 60 districts have been supplied essential equipment for upgrading primary care facilities for newborn care.

FOR PREGNANT WOMEN

- Early registration
- Institutional deliveries and deliveries by skilled birth attendant.
- Immunization against tetanus—100% coverage.
- Anemia prophylaxis and oral therapy—100% coverage.
- Antenatal check-up—at least 4 check-ups in 100% women.
- Referral to First Referral Unit (FRU) of those with complications.
- Care at birth—Promotion of clean delivery, i.e. clean hands, clean surface, clean razor blade, clean cord tie, clean cord stump (no cord applicator). 5Cs
- Birth-timing and spacing.
- Home based postnatal care
- Increased facilities for MTP

Essential obstetric care include early registration of all pregnancies ideally in the first trimester (before 12th week of pregnancy), minimum 4 antenatal check-ups and provision of complete package of services. 1st visit: Within 12 weeks—preferably as soon as pregnancy is suspected—for registration of pregnancy and first antenatal check-up, 2nd visit: Between 14 and 26 weeks, 3rd visit: Between 28 and 34 weeks, 4th visit: Between 36 weeks and term.

Associated services like providing iron and folic acid tablets, injection Tetanus Toxoid, etc. should be ensured. At least 1 ANC preferably the 3rd visit, must be seen by a doctor. Minimum laboratory investigations like hemoglobin, urine albumin and sugar, RPR test for syphilis should be conducted.²⁸

Pregnancy is confirmed by pregnancy color card. Hemoglobin is estimated by hemoglobin color scale, and glucose protein in urine is assessed by urine reagent strips.

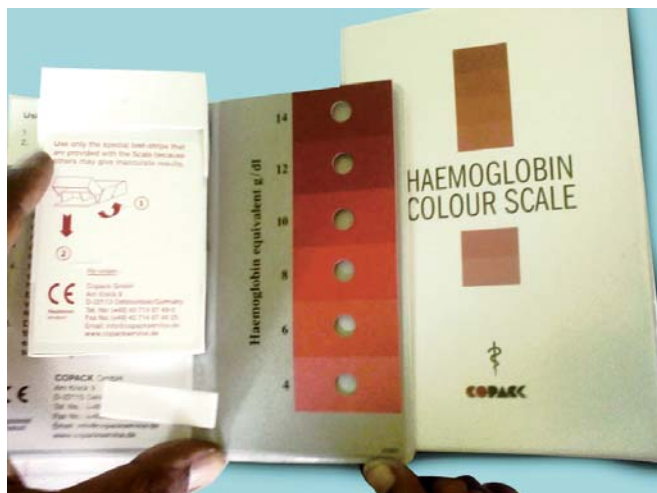


Fig. 30.8: Hemoglobin color scale

Hemoglobin estimation by hemoglobin color scale. **(Fig. 30.8)** The hemoglobin color scale is a simple device for estimating hemoglobin. It is used when laboratory hemoglobinometry is not available. The color scale kit consists of a booklet containing a set of six shades of red and a pack of special absorbent test-strips. **(Table 30.8)** The shades represent a range of hemoglobin values from 4 to 14 g/dL. By matching the color of a drop of blood on a test-strip with one of the shades of red, one can see if the blood is anemic and, if so, the severity of anemia in clinical terms.

Instruction for use:

- Use only approved test strips.
- Add a drop of blood to one end of a test strip – just enough to completely cover an aperture in the color scale.
- Wait about 30 seconds; then read immediately by comparing the blood stain with the color scale to find the best color match.
- Keep the test strip close to the back of the color scale.
- Avoid direct sunlight.
- Avoid marked shade.
- Avoid any shadow.
- If the blood stain matches one of the shades of red exactly, record the hemoglobin value. If the color lies between two shades, record the mid value. If in doubt between two shades, record the lower value.
- Discard the test strip after use. Wipe the back surface of the scale at the end of each session or if it becomes soiled during use.

TABLE 30.8: Interpretation of hemoglobin color scale

Hemoglobin level	Interpretation
12 g/dL or more	Not anemic
8 – 11 g/dL	Mild to moderate anemia
6 – 7 g/dL	Marked anemia
4 – 5 g/dL	Severe anemia
Less than 4 g/dL	Critical

Districts in the country have been classified into three categories, viz., A, B and C on the basis of available CBR and female literacy rates. Category 'A' has 58 districts, 'B' has 184 districts and 'C' has 265 districts. Category 'A' has highest level of these indices while 'C' has the lowest, e.g. large northern states have relatively weaker record of delivery basic MCH services, whereas those on southern region of the country have achieved high levels of performance in delivery basic package of family welfare services. Thus it makes sense to introduce higher and sophisticated services in the relatively advanced region where the backward regions needs to be assisted for strengthening and improving basic services. In order to improve delivery of these services all category 'C' districts (most backward districts) in Uttar Pradesh, Delhi, Uttaranchal, Bihar, Jharkhand, Madhya Pradesh, Chattisgarh, Orissa, Haryana, Rajasthan and North-East states are being supported for additional ANMs in remote subcenters up to 30% of the total number. Public Health Staff Nurses are also being provided to 25% of Category 'C' PHC and 50% of Category "B" PHCs.

Other services

- Increased choice and availability of family planning services, gender sensitization, gender equality.
- Adolescent reproductive and sexual health.
- Prevention and management of RTIs and STIs.

Strategy

The opportunities created by the immunization program would be utilized for effective delivery of the above-mentioned components. In operational terms, these would be integrated with the immunization program so as to have:

- Unified training for all levels of functionaries
- Unified logistics for all interventions
- Unified monitoring and supervision
- Integrated management information system
- Integrated communication.

Implementation

The program will be expanded in a phased manner. It will be implemented as a 100% centrally sponsored family welfare program by the State Government and UTs within the broad framework of the guidelines provided by the Department of Family Welfare.

Since the program is envisaged to be implemented through the existing primary health care infrastructure:

- All subcenters in the country will receive the recommended drugs for subcenters use, and the subcenter midwifery kit.
- In addition, subcenters in high IMR or high IMR districts will receive other equipment for working at subcenters.

- Each female health worker will receive contingency money for meeting her day-to-day expenditure and for payment of reporting fees to trained birth attendants (TBAs).
- All TBAs conducting, referring or reporting a birth will receive their reporting fee from the female health worker immediately.

Other activities under the RCH program being currently implemented include:

- **RCH camps:** In order to provide RCH services to people living in remote areas where the existing services at PHC level are under-utilized, a scheme door holding camps has been initiated during 2001. Initially 102 districts in 17 States have been identified for this activity. More districts would be added in the financial year 2001-2002.
- **Dai training:** A new scheme for Dai training has been initiated in 2001 to tackle the problem of unsafe deliveries in 142 districts in 17 States, having safe delivery rates less than 30%.
- **Emergency obstetric care:** These services are being strengthened through supply of drugs in the form of emergency obstetric drug kits and anesthetists on contractual or hiring basis. European Commission is assisting in this activity.
The three Es to reduce maternal mortality are:
E1: Essential obstetric care for all
E2: Early detection of complications
E3: Emergency services for those who need it.
- **Referral transport:** Women from indigent families suffering obstetric complications in 25% of Category 'C' districts of selected States are provided transport for emergency care. This is operationalized through a corpus fund to Panchayat. Since 2001 this scheme has been extended to all Category 'C' districts in all States in the country.
- **MTP services.**
- **Reproductive tract infections (RTI) and sexually transmitted infections (STI) control:** This is now an integral part of the RCH program. 429 such clinics have been set up in the country. In partnership with NACO, National Family Health Awareness campaigns have been organized. Laboratory technicians on contractual basis are also being provided. Drugs for RTI/STI and consumable laboratory items are also provided.
- **Integrated financial envelop:** Flexibility has been granted to 6 States to design a package of interventions to address Maternal Health Care.
- **Border districts cluster project:** This was launched in 2000 in 47 identified districts in 16 States. These districts are provided additional inputs with UNICEF assistance to reduce IMR and MMR by 50% over a 4 years period.
- **Improving outreach services:** A new scheme has been launched in 50 selected districts in 8 weeks

States (Assam, Bihar, Madhya Pradesh, Orissa, Rajasthan, Uttar Pradesh, West Bengal and Gujarat. The inputs include increased mobility of staff, supervision of field activities and demand generation by launching local level IEC activities.

- **Community needs assessment approach (CNAA):** This earlier known as Target Free Approach (TFA) was launched in 1996 following abandonment of specific contraceptive targets for achievement.
- Area projects are functional in identified backward areas.
- **India population project VIII (IPP):** The World Bank Assisted Project is currently functional in 4 cities—Delhi, Bangalore, Hyderabad and Kolkata for improving the Health and Family Welfare Status of urban slum populations.
- **India population project IX:** This activity supported by the World Bank is functional in entire State of Assam, 10 backward districts of Rajasthan and 13 backward districts of Karnataka.
- **Integrated population and development project (IPD):** This UNFPA funded activity is being implemented in 32 districts in 6 states (Maharashtra, Rajasthan, Kerala, Orissa, Gujarat and Madhya Pradesh for a period of 4 years).
- **RCH initiative for north east:** A special project is being initiated.
- **Urban RCH initiatives:** Projects have been taken up in Lucknow, Bhopal, Indore and Jabalpur and will be extended to other cities.
- **European commission assisted health and family welfare program:** This program is a 200 million Euros program, funded by the European Commission. It is an integral part of the Reproductive and Child Health Program. The focus of the assistance is to catalyze operational, technical and managerial reforms at state and below levels to make decentralization of responsibility, community participation and need based efficient and quality health service delivery a reality. Besides national level activities, reform activities in AP, Assam, Gujarat, Haryana, HP, Kerala, MP, Maharashtra, Orissa, Rajasthan and UP (11 states) by way of state level activities, policy studies, pilots, etc. and decentralization of planning for identified needs in 21 selected districts/urban areas, is being undertaken in the first year of Sector Investment Program, which has received approval in Nov 1999. This will be extended to 60 districts in these states or other states as may be mutually agreed, by the end of IX five-year plan (1997-2000).

NATIONAL RURAL HEALTH MISSION (NRHM)

The Government of India launched the National Rural Health Mission in 2005. One important component of NRHM is to improve the availability and accessibility of

maternal health care services to rural women to ensure safe motherhood. The maternal care services include antenatal care, delivery care, and postnatal care. Antenatal care services include provision of at least three antenatal care visits; iron folic acid tablets; two injections of tetanus toxoid; detection and treatment of anemia and management and referral of high risk pregnancies. Delivery care services include skilled birth attendance for all deliveries and provision of emergency obstetric care to those with complications. Postnatal care services include checking mother and newborn; follow-up visits to women and newborns; and advice on family planning, breastfeeding and newborn care. The NRHM seeks to focus on 18 states which have weak public health infrastructure and indicators. These states are Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Himachal Pradesh, Jharkhand, Jammu and Kashmir, Manipur, Mizoram, Meghalaya, Madhya Pradesh, Nagaland, Orissa, Rajasthan, Sikkim, Tripura, Uttaranchal and Uttar Pradesh.²⁹

The expected national outcomes from the Mission during 2005-2012 are:²⁹

- Infant mortality rate reduced to 30 per 1,000 live births by 2012
- Maternal mortality reduced to 100 per 100,000 live births by 2012
- Total fertility rate reduced to 2.1 by 2012
- Malaria mortality reduction rate of 50% up to 2010, and an additional 10% by 2012
- Kala-azar mortality reduction rate of 100% by 2010 and sustaining elimination until 2012
- Filariasis/microfilaria reduction rate of 70% by 2010, 80% by 2012, and elimination by 2015
- Dengue mortality reduction rate of 50% by 2010 and sustaining that level until 2012
- Cataract operations increasing to 46 lakhs until 2012
- Leprosy prevalence rate reduction from 1.8 per 10,000 in 2005 to less than 1 per 10,000 thereafter
- Tuberculosis DOTS series maintenance of an 85% cure rate through the entire mission period and sustaining the planned case detection rate
- Upgrading all Community Health Centers to Indian public health standards
- Increasing the bed occupancy rate of First Referral units from less than 20% of referred cases to over 75%
- Engaging 400,000 female Accredited Social Health Activists (ASHAs)

National Immunization Program

Routine Immunization is one of the most cost effective public health interventions. The WHO launched the Expanded Program of Immunization (EPI) in 1974 with the objective of reducing morbidity and mortality due to six common preventable childhood diseases, viz.

tuberculosis, diphtheria, pertussis, tetanus, poliomyelitis and typhoid. This EPI was first introduced in India in 1978 after small pox eradication and was limited to mainly urban areas.

Universal Immunization Program (UIP) was introduced in 1985 in memory of Late Smt. Indira Gandhi and was expanded to entire country. Measles vaccine was included instead of typhoid vaccine. Close monitoring was done in less than 1 year of age group.

IMMUNIZATION SCHEDULE

The national immunization schedule for infants consists of one dose of BCG, OPV – 0 dose and Hepatitis B birth dose at birth or soon thereafter, three doses of DPT, OPV and Hepatitis B at monthly intervals, starting as early as six weeks of age, and one dose of measles vaccine at 9 months of age. One additional dose of both DPT and OPV is recommended 12 months after the third dose. Children over 12 months of age are not denied primary immunization services on demand. Two doses of TT vaccine (with an interval of one month) are recommended to women during their first pregnancy and one booster dose is recommended in each subsequent pregnancy (**Table 30.9**).

Adequate antibody titres against tetanus develop only about 3 weeks after the second dose of TT. It is, therefore, important that the 2nd dose be given at least

TABLE 30.9: National immunization schedule

For infants	
At birth	– BCG, OPV – 0, Hepatitis B birth dose (for institutional deliveries)
At 6 weeks	– BCG (if not given at birth)
At 10 weeks	– DPT-1, OPV-1 and Hepatitis B-1
At 14 weeks	– DPT-2, OPV-2 and Hepatitis B-2
At 18 weeks	– DPT-3, OPV-3 and Hepatitis B-3
At 9 months	– Measles 1
At 16–24 months	– DPT B1, OPV B, Measles 2
At 5–6 years	– DPT B2
At 10 and 16 years	– TT – the second dose of TT vaccine should be given at an interval of 1 month if there is no clear history or documented evidence of previous immunization with DPT, DT or TT vaccine.
» If child has diarrhea, give a dose of OPV, but do not count the dose and ask the mother to return in 4 weeks for the missing dose	
» Japanese Encephalitis vaccine (SA 14-14-2 Vaccine – 0.5 ml, subcutaneously, left upper arm) is given in selected endemic districts after campaign, at 16-24 months of age along with DPT/OPV booster.	
» Vitamin A is started at 9th month of age along with measles vaccine, 2nd dose is given along with DPT and OPV – booster dose and thereafter every 6 months upto age of 5 years.	
For Pregnant Women	
Early in pregnancy	– TT-1 or booster *
One month after	– TT-1 – TT-2

* 1 booster dose is needed if a mother becomes pregnant within 3 years of the previous pregnancy, when she received 2 TT injections (documented).

one month before the expected date of delivery. It is recommended that the first dose be given on first contact during pregnancy, the second dose being given not earlier than one month after the first. If the woman has received TT previously, one dose during the current pregnancy will be sufficient. If a pregnant woman reports late and there is not time to complete 2 doses, only one dose may be given.

In India, children get the diseases at an early age. For example, in communities with low immunization coverage levels, 25 to 33% of all cases of polio occur in children under one year and more than two-thirds in children under two years of age.³⁰ Hence the timing of the first dose has been reduced from 3 months, recommended earlier, to 6 weeks. The interval between the doses of polio or DPT should be 4 to 6 weeks. However, if the child is brought later than the due date for the next dose, it can still be given without starting all over again. Malnutrition, low grade fever, mild respiratory infections, diarrhea and other minor illnesses are not contraindications to vaccination. It may have to be deferred only in critically ill children with high fever (38°C or more) and in those requiring hospitalization.³⁰

Proposed Changes in the National Immunization Schedule in 2009-10³¹

- In select well-performing states, MR to be given with DPT Booster at 16 to 24 months (Dose: 0.5 ml; Route: Subcutaneous; Site: Right Upper Arm)
- DPT and Hep-B vaccines at 6, 10 and 14 weeks to be replaced by DPT-HepB-Hib (Pentavalent) vaccine.

ADVERSE EVENT FOLLOWING IMMUNIZATION (AEFI)

An adverse event following immunization is defined as a medical incident that takes place after an immunization, causes concern, and is believed to be caused by immunization. AEFIs, particularly when they are not properly managed, represent a genuine threat to the immunization program and, in some cases, to the health of the beneficiaries. It is important that AEFIs are detected, investigated, monitored and promptly responded to for corrective interventions. The AEFI have been classified as following:³¹

Classifications of AEFIs

Vaccine reaction: An event caused or precipitated by the active component or one of the other components of the vaccine (e.g. adjuvant, preservative or stabilizer). This is due to the inherent properties of the vaccine. Examples being common, minor vaccine reactions like local reaction (pain, swelling, redness), fever and systemic symptoms (e.g. vomiting, diarrhea, malaise) that may result as a part of the immune response. An ideal vaccine reduces these reactions to a minimum while producing the best possible immunity.

Program error: An event caused by an error in vaccine preparation, handling or administration. The most common program error is infection as a result of nonsterile injection or poor injection technique. The infection can manifest as a local reaction (e.g. suppuration, abscess), systemic effect (e.g. sepsis or toxic shock syndrome), or blood-borne virus infection (e.g. HIV, Hepatitis B or Hepatitis C). Use of reconstituted vaccines beyond the stipulated 4 hours, reuse of reconstituted vaccine at subsequent sessions, reuse of disposable syringe and needle, reconstitution error/wrong vaccine preparation, injection at incorrect site/route (BCG given subcutaneously), contraindications ignored like administration of DPT vaccine after having reaction with the first dose are some examples of program error.

Coincidental: An event that occurs after immunization but is not caused by the vaccine. This is due to a chance temporal association. There is clinical/laboratory evidence that the event is not related to immunization. Once an event is established as coincidental (e.g. pneumonia after administration of OPV) no further investigation is required, other than what would be needed for the clinical management of the case.

Injection reaction: Event caused by anxiety or pain from the injection itself rather than the vaccine. This reaction is unrelated to the content of the vaccine. Examples being fainting, lightheadedness, dizziness, tingling around the mouth and breath-holding in younger children, etc.

Unknown: Unknown AEFIs imply that the cause of the event cannot be determined. The other possible above mentioned causes must be excluded before reaching this conclusion.

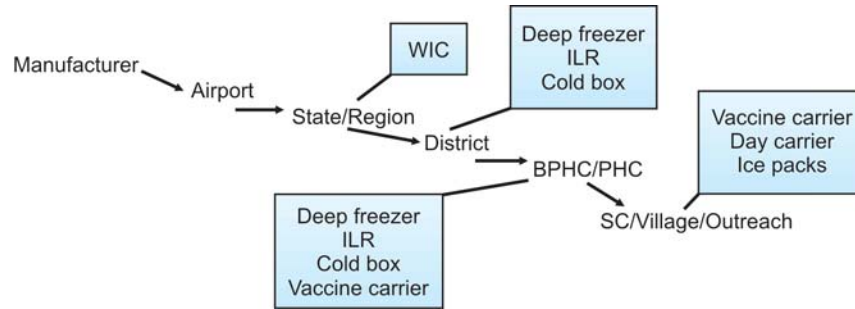
Investigating of AEFIs

On receiving reports of AEFIs, investigations must be started immediately with the following steps:

- Confirmation of the reported diagnosis of AEFI and clarification of the details and outcomes.
- Searching of the unimmunized persons, whether they are experiencing the same medical events or not.
- Determination whether a reported event was isolated or part of a cluster.
- Investigation of any link between the vaccine given and the development of AEFI.
- Finding out any contribution of operational aspects of the program to the reported AEFI.
- Ascertain the cause of the AEFI to provide the best medical care and take further actions as necessary.

COLD CHAIN

The cold chain is a system of transportation and storage of vaccine at recommended temperature from the manufacturer to the point of use.^{26,31}



- There are three essential elements of cold chain like
- Personnel: to organize and manage vaccine distribution
 - Equipment: to store and transportation of vaccine
 - Procedures: to ensure vaccines are stored and transported at recommended temperature.

COLD CHAIN EQUIPMENTS

Cold chain equipments (both electrical and nonelectrical) are used for storage and transportation of vaccines at recommended temperature.

General principles for proper functioning of all electrical cold chain equipments:

- These should be kept in a cool room, away from direct sunlight or any heat source.
- Should be locked and key is accessible to one designated personnel.
- Should be placed at least 10 cm away from walls.
- Should be leveled, preferably on wooden blocks.
- Should be properly connected to one voltage stabilizer per equipment.
- Should be defrosted periodically, when there is more than 0.5 cm of frost in ILR and Deep freezer. Whenever a thick layer of ice is formed inside the freezer, the inside temperature goes up, thus decreasing the efficiency of refrigerator.
- A paper should be pasted outside the refrigerator containing the name and contact number of the concerned person in case of a problem or failure.
- Have to record the temperature regularly.

Walk-in-coolers / Cold Room (WIC)

At regional level vaccines are stored here. The temperature being + 2°C to + 8°C.

Ice Lined Refrigerator (ILR)

Ice lined refrigerators are lined with tubes or ice packs filled with water which freezes and keeps the internal temperature at a safe level despite electricity failure. ILRs can keep vaccine safe with as little as 8 hours continuous electricity supply in a 24-hour period. Since ILRs are top-opening, they can hold the cold air inside better than a front-opening refrigerator.

Ice lined refrigerator has two sections—top and bottom. Bottom of the ILR is the coldest part and in

top portion, there is a basket. Current recommendation is to store all vaccines on the basket. If baskets are not available, store vaccines (other than OPV and Measles) over two rows of empty ice-packs kept on the platform of the ILR. Measles and OPV can be kept over two rows of empty ice-packs on the floor of the ILR. Twice daily temperature recording (morning and evening) is done with hanging thermometer placed in basket.

At the District level vaccines are stored for 3 months and at PHC level stored for 1 month.

Deep Freezers (DFs)

Under the program, top opening DFs are provided. At the PHC level, DFs are used only for preparation of ice packs and are never used for storing any vaccines and at district level it stores OPV in addition to preparation of ice packs. About 20 to 25 icepacks can be prepared by a 140 Liter DF in 24 hours with at least 8 hours of continuous electricity supply. The temperature in DF is between – 15°C and – 25°C.

Domestic Refrigerators

They also maintain a cabinet temperature between +2°C to +8°C with a holdover time of only 4 hours. Therefore, they are not recommended for common use in the national program. However, they are used in urban dispensaries and by private practitioners in urban areas due to more assured power supply and nonavailability of ILRs and DFs.

Vaccine Vans

These are insulated vans used for transporting the vaccines in bulk. The vaccines should be transported to the last cold storage point only through vaccine vans. Vaccines should be transported only in Cold boxes with the desired number of conditioned ice packs.

Cold Boxes

These are thick walled, thermally insulated boxes, used for transportation and emergency storage of vaccines and icepacks. Conditioned ice packs are placed at the bottom and sides of the cold box before loading the vaccines in cartons or polythene bags. A thermometer is also kept in the cold box. DPT, DT, Hep B and TT vials are not kept in direct contact with conditioned ice packs.

Vaccine Carriers

It is a thermally insulated box. At PHC level they are used for carrying vaccines (16-20 vials) and diluents from PHCs to session sites like subcenter or outreach sessions. Vaccines can be kept for a period of 12 hours, if not opened frequently. Four conditioned ice packs are placed inside the four side walls of vaccine carriers.

Day Carriers

It is also a thermally insulated box, to carry small quantities of vaccines (6 – 8 vials) to nearby sessions. Two conditioned ice packs are placed inside the day carrier above and below. Nowadays these day carriers are not recommended under UIP.

Ice Packs

These are flat plastic containers filled with water, up to the level marked on their sides. These are frozen in the deep freezer and when placed in nonelectrical cold chain equipments such as vaccine carriers and cold boxes, help increase the holdover time. They are also used to keep reconstituted measles and BCG vaccine on the hole during an immunization session.

Thermometers

Either dial or stem (alcohol) thermometers are used to measure the temperature during storage of vaccines. Alcohol thermometers are more sensitive and accurate as they can record temperatures from -50°C to $+50^{\circ}\text{C}$ and can be used for ILRs and deep freezers.

Some terminologies and general principles related to cold chain³¹

- **FIFO:** First In First Out, i.e. vaccines received first should be dispensed first and **EEFO** – Earliest Expiry First Out, i.e. early expiry date vaccines should be given first are the two important principles that are maintained.
- **Holdover time** is the time taken for increasing the temperature of vaccines at the time of power failure from its minimum range to its maximum range, subject to the condition that the equipment is functioning well. For example, if the inside temperature of an ILR is 2°C at the time of power failure, the time taken up to reach 8°C will be the holdover time of that ILR. Holdover time depends on the frequency of opening the lid, the quantity of vaccines kept inside with adequate space between the boxes, exposure to direct sunlight, different seasons and in the case of nonelectrical cold chain equipments, the condition of icepacks placed inside.
- **Conditioned Icepacks:** When icepacks are removed from a freezer, say about -25°C , they need to be kept at room temperature for long enough to allow the temperature of the ice at the core of the icepack to rise to 0°C . This process is called conditioning. It prevents freezing of freeze-sensitive vaccines. An icepack is adequately conditioned when it sweats, i.e. beads of water cover its surface and the sound of water is heard on shaking it.
- **Vaccines sensitive to heat** (in increasing order of heat stability): BCG (after reconstitution) > OPV > Measles > DPT > BCG (before reconstitution) > DT, Hep B, JE, TT.
- **Vaccines sensitive to freezing** (in increasing order): Hep B > DPT > DT > TT. Thus Hep B is most sensitive to freezing.
- **Cold chain sickness rate** is the proportion of cold chain equipment out of order at any point of time. It should be kept to the minimum acceptable level of less than 2%.
- **Response Time** is the period between sending information regarding breakdown to actually attending by a mechanic. Response Time should be 48 hours for plains and 72 hours for hilly terrain.
- **Down time** refers to the time between breakdown of equipment and its repair or the period for which an equipment remains out of service. An efficient Sickness reporting system contributes greatly to reduce the cold chain sickness rate by reducing the Down Time of the equipment. The down time should be less than 2 weeks for plains and 3 weeks for hilly terrain.
- **Bundling** is the simultaneous availability of a number of related supplies, which ensures that vaccines are always supplied with diluents, droppers, AD syringes and reconstitution syringes, in corresponding quantities, at each level of the supply chain.
- Any used and date expired vials are never kept in cold chain. All opened vaccine vials must be discarded. Keep these vials in the red bag for disinfection and disposal. DPT, DT, Hep B and TT vials are not kept in direct contact with conditioned ice packs.
- Diluents do not need to be stored in cold chain as usual, but they are kept with the vaccines so that proper temperature could be maintained while reconstitution and also not to be misplaced elsewhere. Diluents are stored in baskets of ILR for 24 hours before next session.
- Unused vaccine vials from session sites must be returned to the PHC on the same day by the cold chain and kept in ILR with a marking. It is sent for the next immunization session, but has to be discarded after unopened more than thrice.
- **Shake test:** The shake test is used to determine whether adsorbed vaccines (DPT, DT, TT or Hepatitis B) have been frozen at some point of time in the cold chain. Once the vaccine is frozen it tends to form flakes which gradually settle to the bottom after the vial is shaken. Sedimentation occurs faster in a vaccine vial which has been frozen

as compared to a vaccine vial which has not been frozen.

Test: Shake test is conducted when one suspect that vials could have been frozen. At first a vaccine vial of the same batch number and from the same manufacturer is taken and is frozen until the contents are solid (at least 8 hours at -18°C). Then the vial is thawed by keeping it at room temperature until it becomes liquid. This is control vial. Now this control vial and test vial (suspect vial) are taken together in the same hand and shaken vigorously for 10 to 15 seconds. Now both the vials are kept on a table without moving further. Both the vials are viewed against the light to compare their sedimentation rates.

Interpretation:

- If the test sample shows a much slower sedimentation rate than the control sample, then the test sample has most probably not been frozen and can be used.
 - If the sedimentation rate is similar or more, the vial has probably been damaged by freezing and should not be used.
 - **Stockout** is a condition when no stock is available of a vaccine or other supply. Inadequate Stock is less than the buffer stock (i.e. less than 25% for vaccines and 10% for syringes). Excess Stock is more than the requirement for one month, including the buffer stock (i.e. more than 125% for vaccines and 110% for syringes). *Buffer stock* serves as a cushion or buffer against emergencies, major fluctuations in vaccine demands or unexpected transport delays; it should be 25% for vaccines and 10% for syringes. The *Lead time* refers to the time between ordering of new stock and its receipt. The lead time varies, depending on the speed of deliveries, availability and reliability of transport, and sometimes the weather.
 - **Vaccine vial monitor (VVM):** A VVM is a label containing a heat-sensitive material which is placed on a vaccine vial to register *cumulative heat exposure* over time. The combined effects of time and temperature cause the inner square of the VVM to darken gradually and irreversibly. Before opening a vial, the status of the VVM is always checked.
- Limitations:**
- Vaccine vial monitor does not directly measure vaccine potency but it gives information about the main factor that affects potency: heat exposure over a period of time.
 - Vaccine vial monitor does not measure exposure to freezing that contributes to the degradation of freeze-sensitive vaccines.
 - **Cold chain monitor (CCM):** This is accompanied with vaccine batch and designed to follow the vaccine and keep record of its heat exposure. As like VVM it can not detect freezing.

Warm Chain

It is an interlinked procedure minimizing the risk of hypothermia of newborn babies. The links include – training all persons, provision of clean, warm surface and drying, wrapping material, immediate drying, wrapping and putting the baby to breast, warm cap, covering together and ensuring safe, warm transport if necessary.

False contraindications to immunization:

- Minor illness, chronic diseases (heart, lung, kidney).
- Treatment with antibiotics or locally acting steroids (topical/inhalatn).
- Stable neurological condition (down syn. cerebral palsy, spina bifida).
- Malnutrition, dermatoses, eczema, recent or imminent surgery.
- Personal / family H/O of allergy, asthma, eczema, hay fever.
- Previous history of measles, pertussis, rubella, mumps, etc.
- Family H/O of adverse reaction to immunization/fam H/O convulsion.
- Jaundice at birth or prematurity, contact with infectious disease.

PRODUCTION OF VACCINES

The Central Research Institute (CRI), Kasauli, and the BCG Vaccine Laboratory (BVL), Guindy, Chennai, under the Directorate General of Health Services, the Pasteur Institute of India, Coonoor (PIIC), an autonomous organization, and the Haffkine Bio-Pharmaceutical Corporation Ltd. (HBPCL), Mumbai, a Government of Maharashtra Undertaking, together meet the requirements of the country for UIP vaccines. Part supplies of DPT, TT and measles vaccines are procured from the private sector. Polio vaccine is not yet manufactured in the country.³⁰

PROGRAM PROGRESS

Immunization coverage in infants has increased substantially over the last decade. The target group of the program shifted from children under five years of age in the early years of the program (1977-78 to 1979-80) to children under two years of age. The target was subsequently changed to children less than one year of age after launching the UIP in 1985-86, although older children are not denied immunization services on demand. Effective communication has been recognized as a major constraint in universal immunization. This problem has been successfully dealt within some states by the strategy of having a fixed day for this purpose. For example, the UIP services are available to mothers in Maharashtra on every Wednesday at a predetermined place during fixed hours.

The goals for 2000 AD as regards the national immunisation program and the current level of achievement are given in **Table 26.9** in Chapter 26.

UIP PLUS

UIP plus was launched in 1996 due to the success of the fixed day approach, with UNICEF assistance to add other components to the UIP services so that these may all be available at a single go. These additional components pertain to acute respiratory diseases, diarrhea, Vitamin A deficiency and safe motherhood. This enhanced package has been labeled as UIP Plus and is being implemented in all states.

Integrated Child Development Services

The ICDS, a unique national program of the Government of India, started on 2nd October, 1975. It provides services of health, nutrition and preschool education to the preschool children through a coordinated approach. Implementation of ICDS is done by the Department of Women and Child Development, Ministry of Human Resource Development, at the Central and State levels with active participation of the Health and Family Welfare Staff. A system of training, orientation, continued education, functional monitoring, evaluation and research has been evolved to fulfil the needs of the program. It has effectively utilised the assistance of academicians from the medical colleges of the country. Services of senior teachers of pediatrics and community medicine have been enlisted as honorary consultants to the ICDS Projects. Though success has not been uniform throughout the country, favourable impact of the scheme on different aspects of child development is apparent.³²⁻³⁴ It is the largest program for children and expectant mothers in the world.

Objectives

The objectives of the Integrated Child Development Services are as follows:^{15,34}

- To improve the nutritional and health status of children in the age-group 0-5+ years (up to 72 months).
- To lay the foundations for proper psychological, physical and social development of the child.
- To reduce the incidence of mortality, morbidity, malnutrition and school dropout.
- To achieve effectively coordination of policy and implementation amongst the various departments to promote child development.
- To enhance the capability of the mother to look after the normal health and nutritional needs of the child through proper nutrition and health education.

THE CONCEPT OF ICDS AND THE PACKAGE OF SERVICES

The concept of providing a package of services is based primarily on the consideration that the overall impact will be much larger if the different services develop in an integrated manner as the efficiency of a particular service depends upon the support it receives from related services. For instance, the provision of supplementary nutrition is unlikely to improve the health of the child if he continues to be exposed to diarrheal infections or unprotected drinking water supply.

Services

The above objectives are addressed through a package of services comprising of:

- Supplementary nutrition
- Immunization
- Health check-up
- Referral services
- Non-formal preschool education
- Nutrition and health education.

Beneficiaries

The beneficiaries of ICDS are:

- Children below 6 years
- Pregnant and lactating women
- Women in the age group 15 to 44 years.

Women have been included as beneficiaries of ICDS because the mother has a key role in the physical, psychological and social development of the child.

The delivery of services to the beneficiaries (forming about 41% of total population) is as follows (**Table 30.10**).

TABLE 30.10: ICD services to the beneficiaries

Services	Target Group	Service Provided by
Supplementary Nutrition	Children below 6 years: Pregnant and Lactating Mother (P and LM)	Anganwadi Worker (AWW) and Anganwadi Helper
Immunization*	Children below 6 years: Pregnant Mother (PM)	Auxiliary Nurse Midwife (ANM) / Medical Officer (MO)
Health Check-up*	Children below 6 years: Pregnant and Lactating Mother (P and LM)	ANM / MO / AWW
Referral Services	Children below 6 years: Pregnant and Lactating Mother (P and LM)	AWW / ANM / MO
Preschool Education	Children 3-6 years	AWW
Nutrition and Health Education	Women (15-45 years)	AWW / ANM / MO

*AWW assists ANM in identifying the target group.

A number of new initiatives have been taken up recently to strengthen the impact of ICDS. These include services for adolescent girls in the age group of 11 to 18 years, effective involvement of NGOs and strengthening of monitoring.

Three of the six services namely Immunization, Health Check-up and Referral Services delivered through Public Health Infrastructure under the Ministry of Health and Family Welfare.

Nutrition including supplementary nutrition: This includes supplementary feeding and growth monitoring; and prophylaxis against vitamin A deficiency and control of nutritional anemia. Supplementary feeding support is given for 300 days in a year. By providing supplementary feeding, the AWW attempts to bridge the caloric gap between the national recommended and average intake of children and women in low income and disadvantaged communities. Each children of 6 to 72 months will get 500 kcal energy and 12 to 15 gm protein daily. Severely malnourished children (6 to 72 months) will get 800 kcal energy and 20 to 25 gm protein daily. Pregnant women and Nursing mothers will get 600 kcal energy and 18 to 20 gm protein daily.

Growth Monitoring and nutrition surveillance are two important activities that are undertaken. Children below the age of three years of age are weighed once a month and children 3 to 6 years of age are weighed quarterly. Weight-for-age growth cards are maintained for all children below six years that helps to detect growth faltering and helps in assessing nutritional status. Severely malnourished children are given special supplementary feeding and referred to medical services.

Breastfeeding should be initiated within 1 hour of birth and exclusive breastfeeding is continued for first 6 months. For children in the age group 6 months to 3 years, the existing pattern of Take Home Ration (THR) under the ICDS Scheme will continue. THR should be given in the form that is palatable to the child instead of the entire family.

Children in the age group 3 to 6 years are served with Hot Cooked Meal. Since the child of this age group is not capable of consuming a meal of 500 calories in one sitting, the States/ UTs are advised to consider serving more than one meal to the children who come to AWCs. Since the process of cooking and serving hot cooked meal takes time, and in most of the cases, the food is served around noon. States/ UTs may arrange to provide a morning snack in the form of milk/ banana/ egg/ seasonal fruits/ micronutrient fortified food, etc.

Immunization: Immunization of infants protects children from seven vaccine preventable diseases-poliomyelitis, diphtheria, pertussis, tetanus, hepatitis B, tuberculosis and measles. These are major preventable causes of child mortality, disability, morbidity and related

malnutrition. Immunization of pregnant women against tetanus also reduces maternal and neonatal mortality.

Health check-ups: This includes health care of children less than six years of age, antenatal care of expectant mothers and postnatal care of nursing mothers. The various health services provided for children by anganwadi workers and Primary Health Center (PHC) staff, include regular health check ups, recording of weight, immunization, management of malnutrition, treatment of diarrhea, de-worming and distribution of simple medicines, etc.

Referral services: During health check ups and growth monitoring, sick or malnourished children, in need of prompt medical attention, are referred to the Primary Health Center or its subcenter. The anganwadi worker has also been oriented to detect disabilities in young children. She enlists all such cases in a special register and refers them to the medical officer of the Primary Health Center/ Subcenter.

Nonformal Pre School Education (PSE): This is directed to three to six years old children for providing and ensuring a natural, joyful and stimulating environment, with emphasis on necessary inputs for optimal growth and development. This activity is sustained for three hours a day. The early learning component of the ICDS is a significant input for providing a sound foundation for cumulative lifelong learning and development. It also contributes to the universalization of primary education, by providing to the child the necessary preparation for primary schooling and offering substitute care to younger siblings, thus freeing the older ones – especially girls – to attend school.

Nutrition and health education: This has the long term goal of capacity-building of women – especially in the age group of 15-45 years – so that they can look after their own health, nutrition and development needs as well as that of their children and families. This forms part of BCC (Behaviour Change Communication) strategy.

Anganwadi Centers

For Rural/Urban Projects: One AWC for 400–800 population, two AWC for 800–1600 population and three AWC for 1600–2400 population. Thereafter one AWC in multiples of 800. There will be one Mini – AWC for 150–400 population.

For Tribal /Riverine/Desert, Hilly and other difficult areas/ Projects: One AWC for 300–800 population and one Mini – AWC for 150–300.

Registration of beneficiaries: Since BPL is no longer a criteria under ICDS, States have to ensure registration of all eligible beneficiaries.

TABLE 30.11: Administrative control in the implementation of ICDS

Administrative set-up		Coordinating machinery
CENTER	Department of Women and Child development, Ministry of Welfare	Interministerial meetings at the level of Ministers, Secretaries and other officers are held frequently, as and when needed
STATE	Department of Social Welfare or the nodal Department of ICDS as designated by the State Government	A Coordination Committee with the concerned Minister or the Chief Secretary as Chairman and including representatives of all other concerned departments (e.g. Health, Education, Welfare, Water Supply, Agriculture, Rural Development, etc). Chairmen of SSWB (State Social Welfare Board), SCCW (State Council of Child Welfare) and appropriate Voluntary Organizations should also be the members
DISTRICT	The District level Officer incharge may be Collector DDO/Dy. Commissioner/District Social Welfare Officer/District Woman and Child Welfare Officer, etc.	A Coordination Committee with District Magistrate, Deputy Commissioner, Chief Executive Officer of the District Panchayat or DDO as Chairman; District Social Welfare Officer as Convener; and District level officers of the Departments concerned, representatives of ICCW, CSWB, and other Voluntary Organizations as members

ICDS Team

The ICDS team comprises the Anganwadi Workers, Anganwadi Helpers, Supervisors, Child Development Project Officers (CDPOs) and District Program Officers (DPOs). Besides, the medical officers, Auxiliary Nurse Midwife (ANM) and Accredited Social Health Activist (ASHA) form a team with the ICDS functionaries to achieve convergence of different services.

Funding Pattern

ICDS is a Centrally-sponsored Scheme implemented through the State Governments/UT Administrations. Prior to 2005-06, 100% financial assistance for inputs other than supplementary nutrition, which the States were to provide out of their own resources, was being provided by the Government of India.

From the financial year 2009-10, Government of India has modified the funding pattern of ICDS between Center and States. The sharing pattern of supplementary nutrition in respect of North-eastern States between Center and States has been changed from 50:50 to 90:10 ratio. So far as other States and UTs, the existing sharing pattern of 50:50 continues. However, for all other components of ICDS, the ratio has been modified to 90:10(100% Central Assistance earlier).

Training Infrastructure

There is a countrywide infrastructure for the training of ICDS functionaries, like, (i) *Anganwadi Workers Training Centers (AWTCs)* for the training of Anganwadi Workers and Helpers, (ii) *Middle Level Training Centers (MLTCs)* for the training of Supervisors and Trainers of AWTCs; and (iii) *National Institute of Public Cooperation and Child Development (NIPCCD)* and its Regional Centers for training of CDPOs/ACDPOs and Trainers of MLTCs. NIPCCD also conducts several skill development training programs.

ADMINISTRATIVE SET-UP¹⁵

The administrative unit for the location of an ICDS Project is a community development block in the rural areas, a tribal development block in the tribal areas, and a group of slums in urban areas (**Table 30.11**).

An Anganwadi is the focal point for the delivery of these services to children and mothers in their own communities. An Anganwadi normally covers a population of 1,000 in both rural and urban areas and 700 in tribal areas. 5.92 lakh Anganwadi Centers are currently functional (as in 1998).

An Anganwadi is run by an Anganwadi Worker. The Anganwadi Worker (AWW), a local woman selected from within the community, is an honorary worker and receives an honorarium. She is assisted by a helper who is also a local woman and is also paid a small honorarium. The *responsibilities* of an AWW include:

- Organizing nonformal, preschool education in Anganwadi for children 3 to 5 years of age;
- Organizing supplementary feeding for children under six, pregnant women, and nursing mothers.
- Giving health and nutrition education to mothers.
- Making home visits for education of parents, particularly, mothers.
- Eliciting community support and participation in running the program.
- Assisting the Primary Health Center staff in the implementation of the health component of ICDS Program.
- Maintaining liaison with other institutions in the village and with other village functionaries.
- Maintaining records of the village survey submitting monthly progress reports.

The work of Anganwadi Workers is supervised by Mukhya Sevikas who guide and assist them. A Mukhya Sevika covers 25, 20 and 17 Anganwadis in urban, rural, and tribal projects respectively. Her specific duties include guidance to Anganwadi Workers in household surveys, assuring adequate coverage of target groups,

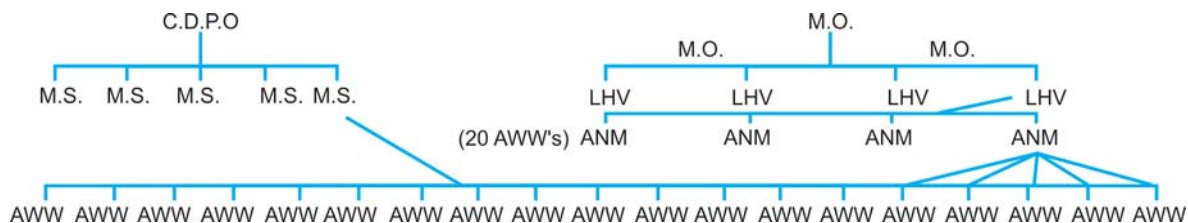


Fig. 30.9: Organizational structure of a rural ICDS project

use of weighing scales and arm bands, conducting home visits, maintenance of records, monitoring immunization coverage and other important support. She acts as a liaison between the Anganwadi Workers and the Primary Health Center staff, which delivers the basic health services of the ICDS Program between Anganwadi Workers and the Child Development Project Officer (CDPO), who is incharge of each ICDS Project.

The CDPO coordinates and implements the ICDS program and is responsible for managing the project. The CDPO supervises and guides the entire project team, including the Mukhya Sevikas and Anganwadi Workers, making field visits and calling staff meetings for this purpose.

All the Anganwadi areas in a project are divided into Mukhya Sevika Circles. The Anganwadi areas are also divided among Auxiliary Nurse Midwives or Multi-purpose Female Health Workers. Ideally, the Health Worker's service area will correspond to that of the Mukhya Sevika in order to facilitate joint visits to the Anganwadis. On an average, an ANM looks after five Anganwadis. A lady Health Visitor looks after the works of about four ANMs. The entire project areas is also geographically divided among the total number of PHC Medical Officers in the block. Each Medical Officer is responsible for all the PHC activities included in the ICDS Program in his area. The organizational structure of an ICDS Project is given in **Figure 30.9**.

WHEAT BASED NUTRITION PROGRAM (WBNP)

The Government of India allocates food grains (wheat and rice) at BPL rates to the States, on their demand, for meeting their requirement for supplementary nutrition to beneficiaries under the ICDS Scheme.

INTERNATIONAL PARTNERS

Government of India partners with the following international agencies to supplement interventions under the ICDS:

- United Nations International Children' Emergency Fund (UNICEF).
- Cooperative for Assistance and Relief Everywhere (CARE).
- World Food Program (WFP).

RECENT INITIATIVES

- Revision in Population norms for setting up of AWCs/ Mini-AWCs.
- Universalization and 3rd phase of expansion of the Scheme of ICDS Special focus on coverage of SC/ ST and Minority population.
- Introduction of cost sharing between Center and States, with effect from the financial year 2009-10, in the following ratio: (a) 90:10 for all components including SNP for North East; and (b) 50:50 for SNP and 90:10 for all other components for all States other than North East.
- Provision of Uniform for Anganwadi Workers and Helpers.
- Introduction of new WHO child growth standards in ICDS: Following the adoption of new WHO growth chart there has been increase in total of normal weight children, increase in severely underweight children and increase in underweight children (mild/moderate and severe) in age group of 0 to 6 months.

ACHIEVEMENTS

There has been significant progress in the implementation of ICDS Scheme during X Plan both and during XI Plan (up to 2008-09), in terms of increase in number of operational projects and Anganwadi Centers (AWCs) and coverage of beneficiaries.

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The family in its literal sense, is a unit consisting of husband, wife and children. It is a well-knit permanent unit of society and the members are dependent on each other for all-round health and welfare—physical, mental, social and economic.

What is Family Planning?

Most parents in India have limited physical, social and economic resources, adequate only for a limited number of children. Too frequent conceptions may be incompatible with health and socioeconomic resources of the parents. If there are too many children in a poor family, they are deprived of adequate care and tend to be ill-nourished and unhealthy. Large family size adversely affects the health and happiness of each member of the family. Family planning would thus mean planning the size of the family in a manner compatible with physical and socioeconomic resources of the parents and conducive to health and welfare of all members of the family. It has been defined by WHO as, “a way of thinking and living that is adopted voluntarily, upon the basis of knowledge, attitudes and responsible decisions by individuals and couples, in order to promote the health and welfare of the family groups and thus contribute effectively to the social development of a country”.¹

Another descriptive definition by WHO² is as follows:

Family Planning refers to practices that help individuals or couples to attain certain objectives:

- To avoid unwanted births
- To bring about wanted births
- To regulate the intervals between pregnancies
- To control the time at which births occur in relation to the ages of the parent
- To determine the number of children in the family.

Scope of Family Planning Services

The aim of family planning is much wider than merely preventing births. The full scope of family planning is discussed below.

Birth Control

This term was coined by Margaret Sanger, the great American lady who championed the cause of family

planning. The idea of limiting or planning the family is now new. In olden times, the attempts at birth control were based on *coitus interruptus*, douches, postures, safe period and the insertion of cotton, lemon or other odd things in the vagina to prevent the union of germ cells. Abortion and infanticide were also resorted to self-restraint or abstinence was also advocated.

Birth control services involve guidance about the *timing*, *spacing* and *number* of children, education regarding contraceptive methods and the provision of facilities for the same. The aim should be to produce children by choice and not by chance. Unwanted pregnancies in married or unmarried women are associated with higher morbidity and mortality in mothers and children. A high abortion rate clearly indicates a high rate of unwanted pregnancies.

TIMING OF BIRTHS

It implies the age at which women should conceive. Maternal morbidity, mortality, complications of pregnancy and delivery are highest when the mother's age is below 20 and over 35 years. Neonatal and fetal deaths are lowest for mothers in their twenties. Congenital anomalies are more common in children born to elderly mothers. Thus the safest time for conception is when the woman is in her twenties.

SPACING OF BIRTHS

Closely spaced pregnancies are associated with anemia and various complications during pregnancy and delivery. Late fetal and early neonatal mortality are lowest when the interval between the termination of one pregnancy and the beginning of the next is not less than 2 to 3 years. Epidemiological studies in Punjab have shown that the infant mortality rate was highest when the birth interval was less than 24 months.

NUMBER

Maternal mortality risk is slightly less with the second and third pregnancy than with the first. It rises beyond the third and significantly so beyond the fifth. A small family norm would thus bring down maternal mortality. Two or three children per couple is an ideal number from the point of view of health and welfare of the

family. A two-child norm is currently advocated in India while China advocates a one child norm.

Management of Sterility and Low Fertility

It should not end with the clinical examination, laboratory tests and prescription of medicines. Efforts should continue till a child is born to the couple or till they decide to adopt a child or to terminate their efforts.

Education about Sexuality

This includes educating the persons of both sexes at different ages as regards anatomical, physiological, psychological, hygienic, social and ethical aspects of sexuality.

Advice Regarding Wise Parenthood

This consists of educating the couples and unmarried young persons, the future parents, about the relationship between their reproductive behavior and their own health and welfare, as also that of their children, community and the country.

Other Aspects

- Genetic counseling
- Premarital advice and examination
- Marriage guidance
- Maternal and child health care
- Early diagnosis of gynecological troubles such as cancer cervix
- Termination of pregnancy, if indicated
- Services to unmarried mothers.

Demographic Considerations in Family Planning

In most of the developing countries, including India, the family planning services have developed on account of the imbalance between population growth and economic development. The National government agreed to family planning by scientific methods through government agencies as early as 1956, when Rs. 5 crores were provided in the Second Five-year Plan. This was done on demographic and economic considerations, since it was realized that though the country had made all-round progress in the fields of education, health, economy, communications and social welfare, the fruits of this progress had not percolated down to the masses because of the simultaneous increase in population. India has only 2.4 percent of the world's land and less than 1.4 percent of world's gross domestic product but one-sixth of the world's population. The government realized that development of resources fell far short of the population increase and hence decided to make all efforts to promote facilities

for family planning. These included allocating sufficient funds for the family planning program, raising the age of marriage (from 14 to 18 years for girls and from 18 to 21 years for boys) and liberalising abortion. Average age of marriage in India in 1971 was 17.2 years for females and 22.4 years for males. This increased to 19 and 24 respectively in 1991.³

It is estimated that the world population was about 5 million in 6000 BC, a number that is added to the world population every month at present. The world population had risen to 250 million by the time of Christ and doubled to 500 million by 1650.⁴ Then an acceleration began. By 1750, it was 791 million, by 1850, 1262 million and by 1950, 2486 million. In 1987, it was estimated to be 4998 million with annual growth rate of 1.9 percent. The current estimate (2000) of world population is 6 billion with annual increase of 1.7 percent. It is likely to reach 8.5 billion in 2050 and may not stabilize till 2150, when it is projected to be 11.6 billion.⁵ However, the rate of increase is not the same in all parts of the world. It varies from minus 0.4 percent per year in Romania to 3.4 in Angola. It is 1.8 percent in India.⁶

The population in India is estimated to be 102.7 crores as per 2001 census. A baby is born every two seconds, about 50,000 a day. Crude death rate (sample registration survey data) is 9.0 per thousand⁷ (SRS 1998). The global population was 6 billion in 2000. 1.5 billion women across the world are in the reproductive age group. 133 million births occur every year in the world, which means that 247 births occur every minute or roughly 4 babies are born every Second, somewhere in the world.⁸

Qualities of a Good Contraceptive

The wide variety of contraceptives available today reflects the fact that an ideal contraceptive is yet to be developed. The desirable qualities in a good contraceptive are listed below.⁹

- *Reliability*, i.e. 100 percent effectiveness.
- *Safety*, i.e. freedom from associated side effects or complications.
- *Reversibility*, i.e. complete return to fertility when the method is discontinued.
- *Low cost*
- *Convenience*: Long acting methods are generally convenient for the user. Methods which are difficult to understand or use, those which must be used at the time of coitus, those which must be used daily and those which need availability of supplies at hand are usually inconvenient.
- *Consumer control*: Most present day contraceptives are meant for use by women. Only temporary male contraceptive in use today is the condom, over which the user has full control. Development of female contraceptives, which they can safely use themselves, will go a long way in promoting family planning.

- *Cultural acceptability:* Some methods needing contact with the genital area or producing menstrual irregularities may be less acceptable in certain cultures.

Unmet Need

There are at least 35 million people who are not using any method of contraception, in spite of fact that they would either like to stop or space child bearing. These women are considered to have unmet need for contraception. The concept of unmet need points to gap between some women reproductive intention and their contraceptive behavior. In doing so, it poses a challenge to family planning programs. Unmet need for family planning among currently married women in 13 percent (NFHS 3).

Methods of Family Planning

The various methods for preventing child birth may be grouped into six categories as classified in **Table 31.1**. Each method has its own merits and drawbacks. The user may make his or her own choice according to individual requirements and preferences (cafeteria approach). The effectiveness of contraceptive methods is measured in terms of pregnancies per 100 users per year. Various methods are listed in **Table 31.2** along with their effectiveness.

It is seen that sterilization is the most effective method. Oral contraceptives and IUD are approximately equally effective.⁹ The different methods of family planning are described below.

TABLE 31.1: Methods of family planning

- *Terminal Methods*
 - Vasectomy
 - Tubectomy
- *Spacing or Nonterminal Methods*
 - Periodic abstinence
 - Barrier methods
 - i. Physical
 - Condom
 - Diaphragm
 - ii. Chemical
 - Foam tablet
 - Jellies, creams, suppositories
 - Soluble films
 - iii. Combined
 - Vaginal sponge
- *Intrauterine Devices (IUD)*
- *Hormonal Methods*
 - Oral pills
 - Depot formulations
- *Postconceptional Methods or Medical Termination of Pregnancy (MTP)*
 - Menstrual regulation
 - Menstrual induction
 - Abortion
- *Miscellaneous*
 - Male contraceptives
 - Antifertility vaccines
 - Female condoms

TABLE 31.2: Failure rates of different contraceptive methods

Methods	Typical failure rate (% of US women experiencing accidental pregnancy during first year of use)
Chancere	85
Spermicides	21
Periodic abstinence	20
Withdrawal	18
Cap	18
Sponge	
Parous women	28
Nulliparous women	18
Diaphragm	18
Condom	12
IUD	3
Pill*	3
Injectable progestogen	0.4
NET DMPA	0.3
Implants	
Norplant (6 capsules)	0.04
Norplant-2 (2 rods)	0.03
Female sterilization	0.4
Male sterilization	0.15

Source: *Combined pill is more effective than progestogen only pill.¹⁰

Coitus Interruptus or Withdrawal

It was recommended by Francis Place, who started the birth control movement in England in 1823. The failure rate is high.

Periodic Abstinence (Safe Period Method)

Periodic abstinence requires the couple to refrain from sexual intercourse during the estimated time of fertility. Ways to determine the approximate time of ovulation and the fertile period include: a calendar method; a basal body temperature method; a cervical mucus method (Billings ovulation method); and a symptothermal method. Each of these methods requires careful instruction. Users of the calendar method, record the length of their menstrual cycles and calculate the time of fertility by subtracting 20 days from the length of their shortest cycle (this indicates the first day of the fertile period) and 10 days from the length of their longest cycle (this indicates the last day of the fertile period). The day of start of menstruation is counted as the first day of the cycle. Users of the temperature method take and record their working temperature and interpret the rise in temperature which follows ovulation; abstinence is required until the 3rd day of the rise in temperature. Since this method denotes only the postovulatory safe period, it is rarely used now in isolation. Users of the cervical mucus or Billings ovulation method monitor and record the sensation and appearance of mucus at the vulva; abstinence is required during menstruation, on all days of noticeable

mucus and for 3 days afterwards (mucus becomes thin and profuse during ovulation and thick and scanty after ovulation). The sympto-thermal method is a combination of the temperature method, the mucus method, the calendar method and other signs of ovulation (e.g. midcycle pain and bleeding).

Spermicidal (Chemical) Methods

- Foam tablets have been widely used for this purpose. The tablet has to be inserted high up in the vagina sometime before intercourse. The foam formed locally kills the sperms when discharged. Success rate is low.
- Spermicidal jelly: It is supplied along with a vaginal applicator. Failure rate is high.

Diaphragm Method

A diaphragm is a soft rubber cup with a stiff but flexible rim around the edge. Contraceptive cream or jelly is put on the surface facing the cervix and the diaphragm is inserted into the vagina before intercourse. The diaphragm covers the entrance to the uterus and the cream or jelly blocks sperm movement. It must be ensured that the diaphragm fits properly. The user should be properly instructed about how to insert it and take it out. The diaphragm must be checked periodically to determine that the rubber has not deteriorated or ripped, and that the size is still correct (the size of the uterus may change after a full-term pregnancy, abortion or miscarriage beyond the first 3 months of pregnancy, pelvic surgery, or a weight change of 10 pounds or more). Because of such constraints, the diaphragm is suitable only for urban areas. It found great favor with the educated class in the early years of the Family Planning Program. The failure rate is low.

Vaginal Sponge

This has been marketed in USA and India under the trade name "Today." It is a small polyurethane foam sponge measuring 5 cm × 2 cm, saturated with a spermicide nonoxynol-9. It is less effective than the diaphragm.

Condom

The condom is a sheath of thin rubber (latex) which is put on man's erect penis before intercourse to collect the semen, keeping the sperm from entering woman's vagina. About ½ inch of the condom is left slack to hold the semen. After climax, but before losing his erection, the man must hold the rim of the condom against the penis as he withdraws, so that the condom does not slip off and the semen is not spilled. A new condom must be used for each act of intercourse. Condom is

the mostly widely used contraceptive in India today. It also prevents venereal diseases. Its acceptability has increased with the availability of ultrathin condoms available nowadays. The three types of condoms marketed today are the ordinary type (thick, nonlubricated), deluxe type (thick, lubricated) and super deluxe type (thin, lubricated). Condom manufacture has increased to cover both family planning and prevention of HIV transmission.

Intrauterine Devices (IUD)

They are foreign bodies introduced into the uterus and retained as long as sterility is desired. Grafenberg in Germany used gold and silver rings in the 1920s. A new device (Ota ring) was introduced by Ota in Japan in 1934. The interest in IUDs was revived after Oppenheimer from Israel and Ishihama from Japan published their excellent results on Grafenberg and Ota rings around 1960.

The Lippes loop was devised by Dr Lippe (1962) in the USA. It is made of polyethylene but also contains barium sulphate to make it opaque to X-rays. This helps in location of the loop when required. It was recommended in 1965 by the ICMR for large scale use. However, Copper-T has now replaced Lippes loop. The Copper-T is a T or Y shaped IUD made of copper having a surface area of 200 sq mm. The copper contained in it has a strong antifertility effect. The various IUDs are shown in **Figure 31.1**.

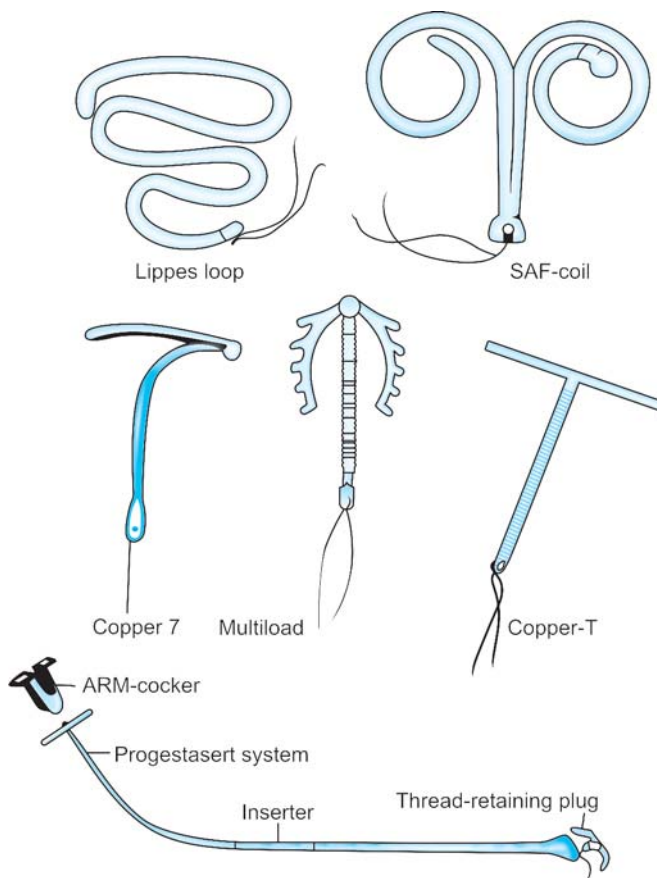


Fig. 31.1: Commonly used intrauterine devices

The IUD's have been labeled as first, second or third generation devices. The first generation IUDs were nonmedicated devices made of polyethylene alone. The second generation IUDs are those which contain copper in addition, which has an antifertility effect. Copper T-200, in which the surface area of copper is 200 sq mm, is in common use in developing countries. It has to be replaced every 2 years. The newer devices are Multiload 250 and Multiload 375 which contain higher amounts of copper. These are common in Western Europe and have an effective life of at least 5 years. More recent devices, T Cu-380 Ag and Nova T, contain both silver and copper and are more effective. Copper stops sperms from making their way up through the uterus into the tubes, thus preventing fertilization. If fertilization does occur, the IUD prevents the fertilized egg from successfully implanting in the lining of the uterus. The third generation IUDs, available only on a limited scale, contain a hormone which is slowly released. A commonly used device is progesterone which is a T-shaped device containing progesterone, a natural hormone. Another device contains levonorgestrel, a synthetic hormone.

ADVANTAGES OF IUD

These are as follows:

- Motivation of the couple by the family planning worker and the visit to family planning clinic is needed only once.
- Easily reversible when pregnancy is desired. The woman wearing it can remove the loop by pulling out the nylon thread. 70 percent become pregnant within 6 months and 90 percent within one year after removal.
- There is no need to specially handle the device before the sexual act, nor to store it or dispose it off secretly as in case of condom or diaphragm, etc.
- High success rate-97 percent.
- Does not interfere with sexual pleasure.
- Inexpensive as compared with other methods.
- A great collateral benefit is diagnosis and treatment of genital diseases because a thorough examination of genital tract is necessary before insertion of the IUD.

Advantages and Disadvantages of Copper IUD

ADVANTAGES

- The Copper-T IUD is the most effective reversible method of birth control currently available in the world.
- It is effective for at least 10 years.
- Only 2 out of 100 women using a Copper-T for 10 years will become pregnant.
- The Copper-T IUD prevents ectopic pregnancies.
- It is far more readily reversible than tubal sterilization or vasectomy.

- The Copper-T is very cost-effective over time.
- It is convenient, safe, and private. Women only have to check the strings each month.
- The Copper-T IUD may be used by women who cannot use estrogen-containing birth control pills.
- It may be used by breastfeeding women.
- The Copper-T may be inserted immediately following the delivery of a baby or immediately after an abortion.

DISADVANTAGES

- There may be cramping, pain, or spotting after insertion.
- The number of bleeding days is slightly higher than normal and menstrual cramping may increase.
- The Copper-T must be inserted by a doctor, nurse.
- A small percentage of women are allergic to copper.¹¹

INSERTION

The loop is inserted into the uterus with the help of an inserter by a doctor. A nylon thread, about 3 cm long, attached to the outer end of the loop, is left in the vagina for pulling out the loop when necessary; it can be felt by the woman with her finger.

MODE OF ACTION

The exact mechanism of action of IUD is not clear even after decades of use. They act as a foreign body in the uterus and cause cellular and biochemical changes in the endometrium and uterine fluids. These changes probably reduce the viability of the ovum and the chance of its fertilization. In addition, copper ions may impair sperm motility and viability, while hormones in the third generation IUDs render the endometrium unfavorable for implantation.

TIME OF INSERTION

Insertion is quite easy after the first childbirth. IUD should be inserted in 6 weeks after delivery and after the first menstrual period following abortion. Insertion may be done any time during the menstrual cycle, preferably on the last day or during menses or a few days after but not in the second half of the month, because pregnancy might have already taken place. However, in case of unprotected or forced intercourse, IUD insertion of a copper device within 3 to 5 days of the intercourse can provide postcoital contraception.

SELECTION OF CASES

It is advisable to insert the loop after a child has been born, so that it has been ascertained that the woman is fertile. Retroverted uterus is no contraindication. Slight discharge does not matter. Mild erosion results in no harm and prolapse can be ignored. Cervical tear, infec-

tion, cesarean section, myomectomy and lactational amenorrhea are not contraindications.

COMPLICATIONS

Many women develop complications after IUD insertion. The following incidence of complications has been noted in large multicenter studies:¹²

Pregnancy	0.5 to 5%
Expulsion	5 to 15%
Removal for bleeding/pain	5 to 15%
Removal for other medical reasons	3 to 9%
Removal for personal reasons	1 to 6%

In spite of the above, continuation rates one year after insertion range between 50 and 85 percent, which is considered a high rate for a reversible method.¹²

Various complications after IUD insertion are described below:

Bleeding

This is the most common complication following IUD usage. 5 to 15 percent women get their IUD removed within the first year because of bleeding. Bleeding may be of three types:

1. Greater volume of menstrual flow
2. Longer menstrual period
3. Midcycle or intermenstrual bleeding.

IUD insertion results in almost a doubling of the average normal menstrual loss of 35 ml per cycle.¹¹ Blood loss is less with copper containing devices, and even lesser with hormone releasing IUDs. Review of a large number of reports suggests there is conflicting evidence whether, in actual practice, the degree or incidence of anemia is increased in IUD users.¹² However, common sense dictates that iron supplements should be given to women having IUD.

Pain

This is the second most common complication. 15 to 14 percent IUD removals are performed due to pain.¹³ The pain may manifest as low backache, abdominal cramps or pain down the thighs. Severe pain during insertion may indicate too large size of IUD, malpositioning of the IUD or perforation.

Expulsion

Large studies indicate an automatic expulsion rate of 5 to 15 percent. One-fifth of all expulsions go unnoticed. IUD expulsion is harmless in itself, but may lead to unwanted pregnancy if undetected.

Pelvic infection

Pelvic inflammatory disease (PID) is 2 to 8 times more common in women using the IUD.¹⁴ The term PID

collectively includes inflammatory conditions, whether acute, subacute or chronic, of ovaries, fallopian tubes and uterus, the related connective tissue and the pelvic peritoneum.¹⁵ Infection is the usual cause. Infection is introduced into the uterus if proper asepsis is not observed during insertion of the IUD. Infection may also ascend from the lower genital tract to the uterus and above through the thread or tail of the IUD.¹⁶ The risk of PID is naturally higher during the first few months after insertion. It is worth remembering that even a single attack of PID can cause infertility due to blockage of fallopian tubes. Clinically, PID presents as fever, chills, vaginal discharge, pelvic pain with tenderness and abnormal bleeding. PID needs to be diagnosed and treated promptly.

Perforation of Uterus

Uterine perforation following IUD insertion is a real possibility, the risk being as high as 0.3 percent, i.e. one in three hundred insertions, even in the hands of trained physicians.¹⁷ An IUD may perforate without any symptoms and the first evidence of perforation may be a missing IUD. A device which has perforated must be removed, otherwise it may cause adhesions or perforation of other organs.¹⁴ Perforation is more common when the IUD is inserted before six weeks of postpartum.

Pregnancy

Pregnancy rate is around 2 per 100 woman years in case of the common IUDs.¹⁸ The rate is higher during the first year after insertion compared to the second year. Expulsion of IUD is found in only one-third of pregnancies, two out of three pregnancies occurring with the IUD in place. Two major complications of pregnancies occurring with IUD *in situ* are spontaneous septic abortion and ectopic pregnancy. Ectopic pregnancy is more common in IUD users. While the ratio of intrauterine to ectopic pregnancy is 300:1 in nonusers, it is 25:1 in IUD users.¹⁸ If pregnancy is detected with a tailed IUD in place, the device should be removed if the tail is readily accessible. Otherwise, termination of pregnancy should be advised. Cesarean¹⁸ section, myomectomy, and lactational amenorrhea are not contraindications for IUD use.

CONTRAINDICATIONS

These are:

- Pelvic inflammatory disease
- Carcinoma of cervix or body of the uterus
- Suspected pregnancy
- Previous ectopic pregnancy
- Undiagnosed vaginal bleeding
- Recent history of menorrhagia or metrorrhagia

- Cervical erosion or cervicitis with marked bleeding or purulent discharge
- Badly lacerated cervix
- Fibroids
- Anemia
- Unmotivated persons.

The first five of the above are absolute and the rest are the relative contraindications.¹³ The Copper-T IUD can be used as an emergency contraceptive. In case of unprotected sex IUD can be inserted up to seven days after sex to prevent pregnancy.¹¹

The *third generation* IUDs contain hormones which are slowly released in the uterus and further enhance the contraceptive effect. They are currently being used only on a very limited scale. The best known type is the progestasert, which is a T-shaped device filled with progesterone, released at the rate of 65 mg per day. Another type contains levonorgestrel, released at the rate of 20 mg per day. According to recent reports, levonorgestrel also controls bleeding while the commonly used copper releasing IUD's, in general, tend to increase bleeding. The new IUD, called LNG-20, is free from this side-effect. So much so that the use of this IUD holds promise as an alternative to hysterectomy and endometrial ablation used as therapeutic procedures for menorrhagia.¹⁹

Progestasert IUD

The Progestasert IUD is shaped like a “T” and contains the hormone progesterone in its vertical arm. This hormone is exactly the same as the progesterone a woman's ovaries produce during each monthly cycle. The progesterone causes the cervical mucus to become thicker so sperms cannot reach the egg. It also changes the lining of the uterus so implantation of a fertilized egg cannot occur. Among typical couples who use the Progestasert IUD, about 2 percent will experience an accidental pregnancy in the first year.

ADVANTAGES

- The Progestasert IUD is safe, convenient. One has to check for the strings each month.
- It provides effective contraception for one year.
- Women who use the Progestasert IUD experience decreased menstrual cramping and decreased menstrual blood loss.
- Though one may bleed for more days, the overall blood loss is less.

DISADVANTAGES

- The IUD commonly causes irregular periods. The number of bleeding days may be greater than normal.
- Some women stop having periods completely.
- There may be some cramping or pain at the time of insertion.

The Progestasert IUD has to be replaced in one year; other IUDs can be left in longer.¹¹

Levonorgestrel IUD

The vertical arm of the IUD contains the hormone levonorgestrel. This hormone is much like the progesterone a woman's ovaries produce during her monthly cycle. Each week the levonorgestrel IUD gives off about the same amount of hormone. The levonorgestrel causes the cervical mucus to become thicker so sperms cannot reach the egg. Among typical couples who use this IUD, one in 1000 will experience an accidental pregnancy in the first year.

ADVANTAGES

The levonorgestrel IUD is the most effective reversible contraceptive method. It prevents ectopic pregnancies and pelvic inflammatory disease, decreases menstrual cramping, and dramatically decreases menstrual blood loss. (One study found a 97 percent reduction in menstrual blood loss). The LNG IUD may be left in place for at least 7 years.

IUDs are safe, inexpensive (in the longterm), convenient, and private. All you have to do is check for the strings each month.

IUDs are far more readily reversible than tubal sterilization or vasectomy.

Given the extremely low failure rate of the levonorgestrel IUD, a person using this method is far less likely to have either the emotional or financial expenses associated with an unintended pregnancy.

DISADVANTAGES

The levonorgestrel IUD often changes the menstrual cycle. There are more bleeding days than normal for the first few months and less than normal after 6 to 8 months. If your bleeding pattern is bothersome, contact your clinician. There are medications which may give you a more acceptable pattern of bleeding.

The IUD provides no protection against sexually transmitted infections. Use condoms if you are at risk for infection.

There is a high initial cost of insertion.

The IUD must be inserted by a doctor, nurse practitioner, nurse midwife, or physician's assistant. As of June 1997, the levonorgestrel IUD is not available in the United States.¹¹

Hormonal Methods

These are of two types—oral pills and depot preparations. Oral pills are of two types: the combined pill and the minipill or progestinonly pill (POP). The depot preparations are of three types: injectable preparations, subdermal implants and vaginal rings.

COMBINED PILL

This is the most common type of pill used nowadays. It is a combination of estrogen and progesterone. Estrogen is a powerful inhibitor of ovulation. Progestogens also inhibit ovulation to some extent, but mainly regulate menstruation by acting on the endometrium and thus ensure a regular menstrual cycle.

The sequential pills used formerly provided estrogen alone in the first half of the cycle and both estrogen and progestogen in the second half. These have been given up now due to less acceptability and effectiveness, as also the risk of endometrial carcinoma. The combined pills used nowadays contain low doses of both estrogen and progestogen. Oral pill is used daily for 21 days, starting on the fifth day of the menstrual cycle. Withdrawal bleeding occurs 2 to 3 days after the last pill. If withdrawal bleeding or menstruation does not occur, the woman is still advised to resume daily intake of the pill 7 days after the last pill at a fixed time, preferably before going to bed at night. If the woman forgets to take the pill at the proper time, she should take it as soon as she remembers it, while continuing to take subsequent pills at the usual time.

Mode of Action

The pill has 3-fold action.

1. It inhibits ovulation by either diminishing the secretion of gonadotropins by the pituitary or preventing them from acting on the ovary.
2. It alters cervical mucosa, rendering it impenetrable to spermatozoa.
3. Progesterone renders endometrium unsuitable to the fertilized ovum for implantation and helps in complete shedding of the endometrium.

Advantages

These are as follows:⁹

- Highly effective
- Easy to use
- Risk of certain pelvic infections is halved
- Risk of ovarian and uterine cancer is halved compared to never users of OCs.
- No increase in risk of breast cancer
- Periods are regular and painless
- Decrease in menstrual blood loss by about 50 percent, thus reducing the risk of anemia.
- Risk of ectopic pregnancy about 10 percent only compared to nonusers.
- Protection against benign cystic breast disease and ovarian cysts.

Disadvantages

These include the following:⁹

- Failure rate increases if the pill is not taken regularly.
- Minor side effects are common, such as headache, nausea, vomiting, breast tenderness, weight gain or

loss and inter-period spotting. These often clear up after 2 to 3 months of use.

- Increased risk of cardiovascular disease (blood clots, heart attacks, strokes, etc.) when OCs are taken by women with pre-existing risk factor (age above 35 years, smoking, high blood cholesterol).
- Hypertension, which is usually mild and is reversible following discontinuation of OC.
- Risk of gallbladder disease is possibly increased.
- Doubtful slight increase in risk of cervical cancer.
- Benign hepatic tumor may rarely occur and may rupture.
- Quantity of breast milk may be decreased.

Contraindications

Absolute

- Present or past history of thromboembolism
- Cancer of breast and genitals
- Liver disease
- Hyperlipidemia, undiagnosed vaginal bleeding.

Relative

Cardiovascular disease, hypertension, diabetes, epilepsy, migraine, age above 40 years, smokers, chronic renal disease, gallbladder disease, amenorrhea and oligomenorrhea. It is also contraindicated during first six months of lactation.

The Ministry of Health and Family Welfare is propagating the use of two preparations, Mala-D and Mala-N in India.

Their composition is given below:

Mala-D : Ethinylestradiol 0.03 mg
D-norgestrol 0.50 mg

Mala-N : Ethinylestradiol 0.03 mg
Norethisterone acetate 1.0 mg

Mala-N is supplied free through PHCs, etc. Mala-D is available in the market at the low cost of Rs. 2/- per pack of 28 tablets, including 7 inert tablets. Most other OCs marketed by pharmaceutical firms cost twice as much and contain 0.05 mg ethinylestradiol instead of 0.03 mg contained in Mala-D. Primovlar-30 is a proprietary preparation with the same composition as Mala-D. Another proprietary preparation with low hormonal content is Triquilar, which was introduced a few years ago and is based upon a new concept of triphasic administration of progestogen-estrogen combinations of varying strength as given in **Table 31.3**.²⁰

TABLE 31.3: Varying strength of pill constituent on the basis of different number of days

Day no.	Constituents of the pill	
	Levonorgestrel (mg)	Ethinylestradiol (mg)
1-6		0.05 0.03
7-11		0.075 0.04
12-21	0.125	0.03
22-28	No pill	No pill

It is claimed that this regimen parallels more closely the normal hormonal cycle of menstruating women.

Among typical couples who initiate use of combined pills about 5 percent will experience an accidental pregnancy in the 1st year. This is because sometimes pills are not used correctly. If pills are used consistently and correctly, just one in one thousand women will become pregnant. A second form of contraception (back up method) should be used for the first seven days of the first pack of pills.¹¹

If a client misses an oral contraceptive pill for three consecutive days:²¹

Some women who have missed three consecutive pills may start withdrawal bleeding. These women should stop taking pills as the contraceptive effect of the pills would be lost. The client should use condom during the rest of the cycle, if needed and should start a new pill packet from the first day of the beginning of the next cycle.

Women who have not started withdrawal bleeding, are potential clients for emergency contraceptive pills. They have several options.

- Those who have had intercourse should take two doses of emergency contraceptive pills and after taking both doses, they should continue to take the rest of the oral contraceptive pills, one tablet daily till the next menstrual cycle starts (this will help the woman maintain the length of her menstrual cycle) and she will use a condom for any further intercourse as the contraceptive effect of the pills is lost once two or more pills of low-dose pills have been missed consecutively and will start a new packet of oral contraceptive pills on the first day of the next cycle.
- Those who have not had intercourse should stop using oral contraceptive pills and use condoms (if any intercourse happens) till the next menstrual period begins and start a new packet of oral contraceptive pills on the first day of the next cycle.

MINIPILL [PROGESTIN-ONLY PILL (POP)]

The progestin-only pill contains the same synthetic progestin as the OC combined pill but no estrogen. The progestin makes the cervical mucus thick and impenetrable to sperm and induces a thin atrophic endometrium. Ovulation is inhibited in about half of the cycles. Minipills are taken continuously.

The progestin-only pill does not affect lactation or cause some of the OC-related side-effects such as high blood pressure and headaches. Theoretically, this pill poses less risk of serious cardiovascular side-effects than combined OCs, but data are incomplete. It decreases painful menses and menstrual blood loss.

The progestin-only pill has a higher pregnancy rate than combined OCs. If the pills are used consistently and correctly just one in 200 women will become

pregnant. Their relative advantages and disadvantages are given below.¹¹

Advantages

- There are no estrogen side-effects. These pills can be taken by women who had side-effects or complications using estrogen containing pills.
- Amount of progestin in many pills is less than in combined pills.
- Minipills are easier to take. One takes exactly the same kind of pill everyday.
- Nursing mothers can take progestin-only pills preferably after the baby is six weeks old.

Disadvantages

- Menstrual irregularity is the most common problem.
- Irregular bleeding and spotting can be observed.
- Failure rate is higher.

It is more likely to cause menstrual irregularity and vaginal spotting and has a relatively high rate of ectopic pregnancy—a life-threatening condition—if untreated.

The progestin-only pill can be considered for women for whom combined OCs are contraindicated. Otherwise, because of the increased ectopic pregnancy rate, it should be used by lactating women only. It should not be used by women who experience abnormal genital bleeding or who have had ectopic pregnancies.⁹

INJECTABLE PREPARATIONS

The two preparations available are DMPA (Depo-Medroxyprogesterone acetate), marketed as Depo-Provera, and NET-EN Norethisterone enanthate), marketed as Noristerat. Out of the two, DMPA has been used more widely and is more reliable. Both contain synthetic progestin hormones that are injected into muscle, from where they are slowly released. They prevent pregnancy by suppressing ovulation, inducing a thin atrophic endometrium and causing thick cervical mucus which is impenetrable to sperm. Several formulations exist: a 3-monthly 150 mg injection of DMPA is the most common but a 2-monthly 200 mg injection of NET-EN and several monthly preparations are also used.

Injectable contraceptives are one of the most effective reversible contraceptives; Among typical couples who initiate use of Depo-Provera, about 3 in 1000 will experience an accidental pregnancy in the first year;²¹ no serious side-effects other than occasional heavy bleeding are known to occur. They are convenient, requiring administration only every 3 months, and they appeal to women who feel confident about medicines given by injection. They do not interfere with lactation. There is no evidence that the minute amounts which pass into breast milk adversely affect the nursing infant. The return of fertility, although sometimes delayed 4 to 8 months, is not impaired. Up

to 25 percent of women discontinue the use of injectable contraceptive because of menstrual disturbances. Heavy bleeding (sometimes requiring estrogen or uterine curettage), is uncommon, but intermenstrual bleeding and amenorrhea (lack of menses) after prolonged use occur in about half of the users. The return of fertility is delayed 4 to 8 months after the last dose. Animal studies have raised concern about uterine and breast cancer, but human studies, to date, have found no increase in cancer.⁹

Injectable contraceptives are especially useful if:

- The timing of the return of fertility is not important.
- A risk of increased cardiovascular complications from OCs is present.
- Other methods requiring daily use are not suitable.
- Estrogen-related complications develop while using OCs (e.g. headache or high blood pressure).
- Amenorrhea is acceptable or desirable.
- Contact with service providers on a regular basis is difficult.

An injectable contraceptive should not be used if pregnancy is suspected, or if undiagnosed abnormal genital bleeding is present. It is usually not used if there is a history of malignancy or cardiovascular disease, although there is no evidence that it would worsen those conditions.⁹

Advantages of Depo-Provera²²

- Nothing needs to be taken at the time of sexual intercourse
- Women lose less blood using Depo-Provera and have less menstrual cramping. Often after three injections women stop periods. This is safe.
- Nursing mothers can receive Depo-Provera injections. It's best after the baby is 6 weeks old.
- Depo-Provera may improve PMS, depression, and symptoms from endometriosis.

Disadvantages²²

- Depo-Provera injections can lead to very irregular periods.
- Some women gain weight.
- A person has to return to clinic every three months for the injection.
- Depression and premenstrual symptoms may become worse.
- It may take a couple of months before periods return to normal after the last injection.
- Depo-Provera may lower estrogen level and cause bone loss.
- Rare allergic reactions have been recorded.

SUBDERMAL IMPLANTS

The Population Council, New York has developed an implant known as Norplant (consisting of six tiny silicone

rubber capsules) or the newer Norplant-R-2 (consisting of two rods). These devices contain the progestin levonorgestrel and are surgically inserted under the skin of the arm by a trained medical practitioner. The tubes allow a steady diffusion of the drug into the bloodstream. The implant must be removed surgically when the steroid is used up (in about 5 years) or when the woman wishes to discontinue the method. The progestin works by blocking ovulation, causing a thick cervical mucus impenetrable to sperm, and inducing a thin atrophic endometrium. The implant is the most effective reversible method. No serious side-effects have been detected but the method is still under study. Infrequent administration is required, as Norplant is effective for at least 5 years. The return to fertility is prompt when desired. It probably does not interfere with lactation, serum liquids or blood pressure.⁷ The implant frequently causes menstrual irregularities, and about 10 percent of users discontinue use for this reason. Insertion and removal require surgical procedures. Indications and contraindications are same as in case of DMPA.

Its effectiveness is 99 percent. It also helps protect against uterine cancer. It can be safely used after child birth and while breastfeeding. It does not interfere with sex.

It cannot be used by women with liver diseases, breast cancers, unexplained uterine bleeding and blood clots. It may not be good for women with high blood pressure, gallbladder disease, alleviated cholesterol, irregular periods, light periods, headaches, heart disease, seizures. Certain drugs (Rifampicin) and most antiepilepsy drugs may reduce effectiveness of implants.

If a woman experiences heavier periods than normal, prolonged periods, missed periods, severe abdominal pains, severe headaches, blurred vision, redness, swelling, pain or bleeding at the implant site or pain in the arm or hand, she should consult a doctor immediately.

After a woman is given a local anesthetic the insertion takes about 7 to 10 minutes. Usually it does not hurt. Norplant implants give off very small amounts of a hormone much like the progesterone a woman produces during the last two weeks of each monthly cycle.

Among typical couples who initiate Norplant implants one in one thousand will experience an accidental pregnancy. If hundred women use Norplant implant for five years only two will become pregnant.²²

VAGINAL RING

This method is not widely used or available. The ring contains levonorgestrel, which is absorbed directly through the vaginal mucosa. It is worn for three weeks of the cycle.

FEMALE CONDOM

These are made of thin plastic called polyurethane which is different from Latex or Rubber. The condom is placed in the vagina, and is open at one end and closed at the other. Both ends have a flexible ring used to keep the condom in place. Among typical couples who use female condoms, 21 percent will experience an accidental pregnancy in the first year. If the condoms are used consistently and correctly, about 5 percent will become pregnant. The advantages and disadvantages are given below:²³

Advantages

- Give women more control and a sense of freedom.
- No prescription or fitting is necessary.
- It can be inserted several hours in advance.
- It is safe and a lubricant can also be used in combination.
- Polyurethane transmits heat well and this may make sex more fun.
- The condom can be safely used if either partner is allergic to latex.

Disadvantages

- It is large, unattractive or odd looking.
- Some women may not like to touch their own vagina.
- It may make a rustling sound during intercourse.
- It needs practice to be used correctly.
- They are three times as expensive as male condoms.

Emergency Contraceptive

Emergency contraception, or emergency postcoital contraception, is a method to prevent pregnancy in women who have had unprotected sex, or for whom a barrier method has failed (slipped condom, diaphragm, or cervical cap, or broken condom).

Indications

- After unprotected sexual intercourse in which no birth control method is used.
- Sexual assault or rape.
- When a condom breaks or a diaphragm slips out of place.
- When a woman forgets to take birth control pills on 3 consecutive days (combined hormone preparation).
- Partial or complete dislodgement of IUD.

Emergency contraceptive pills are not intended for regular use. They are only for emergencies, and should not be used as a routine birth control method, because it is actually less effective at preventing pregnancies than most types of birth control. It is important that women are informed in advance about the option of using

emergency contraceptive pills and where they can get such services because emergency treatment has to be sought within a very short period of time.²¹

Emergency contraception (EC) medicine is not the same as the “abortion pill.” Abortion pill is taken with the intent to end an early pregnancy, while EC pills are taken after unprotected sex to prevent pregnancy from occurring.

Types of Emergency Contraception^{21,24}

Several types of emergency contraception drugs are available.

Levonorgestrel: The progestin-only method uses the progestin in a dose of 1.5 mg, either as two 750 µg (0.75 mg) doses 12 hours apart, or more recently as a single dose.

Combined or Yuzpe regimen: This uses large doses of both estrogen and progestin, taken as two doses at a 12-hour interval. It is possible to obtain the same dosage of hormones, and therefore the same effect, by taking several regular combined OCP i.e. two to five “regular” pills together is equal to one dose of emergency contraception. This method is now believed to be less effective and less well-tolerated than the progestin-only method.

Copper-T intrauterine device (IUD): It can be inserted within 5 days (120 hours) after unprotected intercourse, which can be removed after next period or it may be left in place following the subsequent menstruation to provide ongoing contraception (3–10 years depending upon type).

Mifepristone (RU486): It is an anti-hormonal drug, and does not contain estrogen or progestins. In some countries (China) it is used as an EC pill, but in some other countries (USA) it is used as an abortifacient.

Ulipristal acetate: This drug is similar to mifepristone, was approved in early 2009.

The first widely used pills were five-day treatments with high-dose estrogens, using **diethylstilbestrol (DES)** and **ethinyl estradiol. danazol** was also tested in the early 1980s, but was found to be ineffective.

When to Use

ECPs are effective when used shortly after intercourse and it works best when taken within the first 24 hours. They are licensed for use up to 72 hours after sexual intercourse; but WHO says they can be used for up to 5 days after contraceptive failure.²⁶ Since EC pills can be used up to 5 days after unprotected intercourse, the terms like ‘morning-after’ or ‘post-coital’ pills do not convey the correct timing of use. The only contraindication for the use of ECP is pregnancy. It is primarily because they will not be effective.

Why EC pills are known as contraceptive pills, not an abortifacient?

EC pills are not an abortifacient because it has its effect prior to the earliest time of implantation. Since it acts before implantation, they are considered as contraceptive pills.

Availability

In 44 countries including India, ECP is available through Over-The-Counter (OTC) meaning that no medical prescription is required to purchase the pill. In most of the countries where ECP is approved and registered for use are available through the pharmacies, social marketing, private channels, nongovernmental organization (NGO) clinics and physicians but not introduced in the public sector and not available through its service delivery system. In a number of countries, EC is still not registered and in some countries, it is still a prescription drug.²¹

Mechanism of Action

Emergency contraceptives work mostly by preventing or delaying ovulation—the same way that taking regular birth control pills works. These drugs also work by preventing fertilization, or by preventing a fertilized egg from implanting in the walls of the uterus. Yuzpe and progestin-only emergency contraception will have no effect if taken after implantation, whereas mifepristone can be effective if taken after implantation.

Effectiveness of ECPs

The effectiveness of emergency contraception is expressed as a percentage reduction in pregnancy rate for a single use of EC. Different ECP regimens have different effectiveness levels, and even for a single regimen different studies may find varying rates of effectiveness. Again these depend upon the time when the drug is taken. Levonorgestrel is reported to have an highest effectiveness (89%), compared to the other methods. For both levonorgestrel and Yuzpe regimens, the effectiveness of emergency contraception is highest when taken within 12 hours of intercourse and declines over time.²⁷⁻³⁰

Some enzyme-inducing drugs like *anticonvulsants* or *rifampicin* may reduce the effectiveness of ECP and a larger dose may be required in such cases.

Side Effects

Generally, less than 20 percent women suffer from any side effects and none last for more than 24 hours. The most common side effect reported by users of emergency contraceptive pills was *nausea* and vomiting (more with Yuzpe regimen, and less common with levonorgestrel); If a woman vomits within 2 hours of taking a levonorgestrel-only ECP, she should take a further dose as soon as possible. Other common side effects were *abdominal pain*, *fatigue*, *headache*, *dizziness*, temporary disruption of menstrual cycle and *breast*

tenderness.^{21,27} Side effects usually do not occur for more than a few days after treatment, and they generally resolve within 24 hours.

Safety

There is no medical condition for which the risks of emergency contraceptive pills outweigh the benefits.²⁶ Levonorgestrel is preferable to combined ECPs containing estrogen in women with a history of blood clots, stroke, or migraine.

Role of Emergency Contraceptive Pills in Reproductive Health²¹

- It is a backup support for a very crucial time.
- ECP prevents possible unplanned pregnancy.
- Expanded choice of women for preventing contraceptive failures.
- Abortion, MR, etc. for pregnancy termination is not required.
- EC pills decrease maternal morbidity and mortality.

Postconceptional Methods

MENSTRUAL REGULATION

Menstrual regulation is commonly defined as evacuation of the uterus in a woman who has missed her menstrual period by 14 days or less, who previously had regular periods and who has been at risk of conception.¹⁸ It may be performed before proof of pregnancy. The procedure most commonly used is that of uterine evacuation using a small flexible plastic cannula (Karman cannula) in association with a hand-held gynecological syringe as a source of negative pressure. Cervical dilatation is not needed, except in nulliparous women and in those who are too apprehensive. Menstrual regulation is a relatively safe procedure. Immediate complications include infections, local trauma and perforation. Late complications (after 6 weeks) may be infertility (secondary to infection) and Rh-immunization. Since this procedure is usually carried out without confirmation of pregnancy, it is possible that some women may be subjected to it unnecessarily even without having conceived.

It may be worthwhile pointing out how menstrual regulation differs from abortion. Firstly, it is carried out without a certainty that the woman is pregnant. Secondly, in reference to the first point, there is no legal bar to menstrual regulation in many countries because there is no proof that the woman is pregnant. Thirdly, it is much safer.

MENSTRUAL INDUCTION

This procedure is based upon intrauterine application of prostaglandin F₂ under sedation. This results in sustained uterine contraction for 7 minutes and cyclic contractions for next 3 to 4 hours. Bleeding continues for about a week.³¹

ABORTION

Abortion is termination of pregnancy before the fetus becomes viable, i.e. at 28 weeks (when it weighs approximately 1000 gm). It may be spontaneous or induced. Spontaneous or natural abortion occurs in about 7 percent of all pregnancies. Incidence of induced abortion is not known because it is often unreported, especially when it is illegal. However, abortion rates are high in many countries irrespective of the fact whether abortion is legal or illegal. Illegal abortion, performed clandestinely by untrained persons under unhygienic conditions, frequently result in septic, incomplete abortion.

Early complications of abortion include perforation, cervical injury and excessive bleeding. Late complications include infertility, increased risk of ectopic pregnancy, spontaneous abortion. The risk of death depends upon the conditions under which abortion is carried out and by whom. Abortion in India is allowed only up to 20 weeks.

RU-486 (MIFEPRISTONE)

This is a pill which causes a medical abortion. It is an antiprogesterin that blocks the effect of progesterone on the lining of the uterus. It is followed by taking a prostaglandin called misoprostal 48 hours later. Shortly thereafter 95 percent of women who have this type of medication will abort.

Medical abortion is safe, effective and can be done without any instrumentation and anaesthesia. Cramping and pain may occur while bleeding may last an average of 9 to 12 days. It can only be used up to 9 weeks of pregnancy.

RU-486 is a steroid hormone similar in structure to the natural hormone progesterone. It was invented in 1980 by a French scientist, Dr Etienne-Emile Baulieu.

RU-486 is administered usually (3 pills of 200 mg each) in a clinic. 50 percent of women will bleed within 24 hours. A woman must return to the clinic after 48 hours to receive the prostaglandin which will complete the abortion. The woman stays at the clinic for the next 4 to 6 hours. 90 percent will abort during this period. 1 percent women experience heavy bleeding. Some may experience nausea, vomiting or diarrhea. Incomplete abortion occurs in 2 to 3 percent of cases. Pregnancy may continue in 1 percent.

Ru-486 in conjunction with a prostaglandin is 95.5 percent effective in inducing abortion during the first 7 weeks of pregnancy. RU-486 cannot be used by women receiving long-term corticosteroid therapy or those with blood clotting disorder, chronic adrenal gland failure, ectopic pregnancy or any contraindicators to prostaglandins.

RU-486 has tremendous potential for use in developing countries where thousands of women die

from unsafe abortions each year.¹¹ It is now available in India.

Medical Termination of Pregnancy Act, 1971

The MTP Act was passed by the Parliament in 1971. The induction of abortion has thereby been liberalized. Under this Act, the situations for termination of pregnancy include the following:

THERAPEUTIC

When the continuance of pregnancy endangers the life of the woman or may cause grave injury to her physical or mental health.

EUGENIC

When there is risk of the child being born with serious physical or mental handicap. This may occur:

- If the pregnant woman in the first three months suffers from:
 - German measles (incidence of congenital defects 10 to 12%).
 - Smallpox or chickenpox
 - Viral hepatitis
 - Toxoplasmosis
 - Any severe viral infection.
- If the pregnant woman is treated with drugs like thalidomide, cortisone, aminopterin and antimitotic drugs or consumes hallucinogens or antidepressants.
- If the mother is treated by X-ray or radioisotopes.
- If the parents suffer from insanity.

HUMANITARIAN

When pregnancy has been caused by rape.

SOCIAL

- When pregnancy has resulted from contraceptive failure in a married woman, and is likely to cause grave injury to her mental health.
- When social or economic environment, actual or reasonably foreseeable, can injure the mother's health.

Only a qualified registered medical practitioner possessing prescribed experience can terminate pregnancy. The consent of the woman is required before conducting abortion; written consent of the guardian is required if the woman is a minor or a lunatic. The pregnancy should be terminated in government hospitals or in hospitals recognized by the government for the purpose. If the period of pregnancy is below 12 weeks, it can be terminated on the opinion of a single doctor. If the period of pregnancy is above 12 weeks, but below 20 weeks, two doctors must concur that there is an indication. Once the opinion is formed, the termination

can be done by any one doctor. In an emergency, pregnancy can be terminated by a single doctor (even after 20 weeks) without consulting a second doctor, in a private hospital which is not recognized. The doctor is protected from any legal action for any damage caused or likely to be caused in terminating the pregnancy, provided he has acted in good faith and exercised proper care and skill.³²

Under the rules, a place/clinic in the private sector has to be recognized by the State Directorate of Health Services. Facilities for training and equipment have also been made available free of cost for private clinics. The MTP Act has also been modified to include imprisonment for 5 to 10 years for those performing illegal abortions. It is also envisaged that equipment for MTP will be supplied to all PHCs where a lady doctor trained in MTP procedures will be posted by the State Government.³³

Sterilization

The relative simplicity of present sterilization technology and the known minimal side effects following sterilization make it an appropriate procedure for those who have attained their desired family size.⁶

VASECTOMY

Vasectomy is a safe permanent method of contraception in which the tubes through which sperm travels from the testes to the penis are cut and blocked so that spermatozoa can no longer enter the semen that is ejaculated. The operative procedure is carried out under local anesthesia through a small scrotal incision on an outpatient basis. Long-term health effects appear to be negligible.

Sterilization requires skilled medical practitioners. Minor complications, including swelling and pain, are common. Blood clots, infection and epididymitis occur in 1 to 2 percent of patients; deaths (from infection) are very rare when operative conditions are satisfactory. About 10 ejaculations are necessary before sterility is certain.⁹ Sterilization should be used only if no more children are desired and should be considered a permanent method, although sophisticated microsurgical techniques may reverse it in about 50 percent patients.

Nonscalpel vasectomy: This new method of male sterilization^{34,35} is being actively promoted by the WHO. It was developed in 1974 by Dr Li Shungiang at Chongging Family Planning Scientific Research Institute, People's Republic of China. In contrast to the standard incisional method of vasectomy, which requires several pieces of surgical instruments, this new technique needs only two essential instruments. The first is the vas fixation clamp, used to grasp the vas deferens from outside of the scrotal skin, and the second is the vas dissecting

clamp, used to make a puncture into the skin overlying the fixed vas. After widening of the initial punctured hole with the vas dissecting clamp, the vas can be seen and elevated out for any preferred methods of vas occlusion. The procedure for the second vas is performed through the same hole punctured earlier. At the end of the procedure, suturing of the wound is not needed, only a small piece of guaze bandage is required for wound dressing.

The nonscalpel vasectomy method is superior to the standard incisional technique because: (i) it eliminates the fear of surgical incision, (ii) it can be performed much more quickly, and, (iii) it involves fewer complications than the standard incisional technique.

After infiltration of anesthetic, the vas is immobilized the anterolateral aspect of the scrotum. No sutures are used and the skin is covered with a tincture benzoin seal. The average time taken is only 5 minutes. Barrier contraceptives should be used for 20 ejaculations.

The procedure is safe and simple, minimally invasive, very cheap and can be performed on an OPD basis. There are no complications and reversal is possible.³⁶

TUBECTOMY

Tubectomy is a permanent method of contraception in which the fallopian tubes are closed so that the egg cannot travel through them to meet the sperm. The tubes are surgically closed with bands, clips, electrocautery or by cutting and tying. The operation can be performed under local anesthesia on an outpatient basis through a small incision (minilaparotomy) or through a laparoscope. Worldwide it is the most commonly used method of birth control.

Tubectomy requires skilled medical practitioners and a medical infrastructure. Complications are rare but bleeding, infection, injury to other organs and complications of anesthesia may require further medical therapy; very rarely, such complications may be fatal. Reversibility is limited and requires sophisticated procedures. Failure, i.e. subsequent pregnancy, is rare but does occur. Tubal sterilization is very effective but not 100 percent effective. The failure rate is 1 to 5 percent during the first 10 years after the operation.¹¹ Anatomical abnormalities may make some techniques inappropriate for some women.

Because of the risks of general anesthesia, laparoscopy or minilaparotomy should be performed under local anesthesia. The tubal closure should be performed by surgical ligation, band or clip. Electrocautery should be avoided because of higher risk of damaging other organs and structures.⁷ Serious postoperative complications of female sterilization are bleeding, shock, infection and bowel injury. Signs of complication, are fever (greater than 100°F or 37.8°C), weakness, rapid pulse, persistent abdominal pain, vomiting and pus or tenderness at the surgical site.

Tubectomy may be performed postpartum (after delivery) or interpartum (between deliveries). The traditional method of abdominal tubectomy is particularly suitable during the early postpartum period (24-36 hours after delivery), because the refined surgical technique needs an incision only 2.5 to 3 cm long. If well-trained and experienced surgeons are available and if the patient has no pelvic pathology, a still better method of sterilization is vaginal tubectomy. The major complication of tubectomy is operative failure. In order to minimize this, tubectomy should be performed during the first half of menstrual cycle, i.e. before ovulation. Another method which has gained wide popularity is laparoscopic sterilization using the transabdominal route. This method is used as an outpatients procedure and can be performed in a very short time. However, it obviously requires costly equipment in the nature of an endoscope, as well as trained laparoscopists. The complication rate following laparoscopic sterilization is inversely proportional to the training of the surgeon. Of the various sterilization methods, transcervical methods seem most attractive, as they are relatively simple, less expensive and can be done as an OPD procedure. An ongoing Phase II study is being conducted to evaluate the safety and effectiveness of the STOP transcervical fallopian tube permanent contraception method.³⁷ The device is hysteroscopically delivered and requires no incision or anesthesia. Once inserted into the fallopian tube, it expands to fill the instrumental to isthmic section of the fallopian tube. The multicentric study currently under way in USA, Australia and Europe shows:

- No pregnancies occurred during the follow-up period.
- Good patient tolerance over 302 woman-months of use.

Antifertility Vaccines

EARLY CLINICAL TRIALS

In the late 1970s, the Population Council initiated pharmacological studies in 15 sterilized women, using a prototype vaccine based on the whole beta subunit of hCG, at clinics in Sweden, Finland, Chile and Brazil.³⁸ Shortly afterwards, the All India Institute of Medical Sciences tested an injectable prototype vaccine, also based on the whole beta sub-unit, in 23 healthy, parous women who did not want any more children and were reportedly reluctant to undergo sterilization.³⁹ In this group, eight pregnancies occurred. This caused controversy among scientists on the ethics of including fertile women in such studies.

Two phase I clinical trials on safety aspects were conducted in the 1980's: under the auspices of the Population Council in India and Scandinavia, 88 sterilised women used a prototype based on the whole

beta subunit of hCG,⁴⁰ and an HRP-sponsored trial of a prototype based on the beta-hCG peptide was conducted in Australia in 30 sterilised women.⁴¹

These phase I trials paved the way for phase II trials to assess contraceptive efficacy. They demonstrated the ability of the anti-hCG prototypes to induce antibodies against hCG with no notable adverse effects.⁴² Despite cross-reactions of the vaccine based on the whole beta subunit of hCG with LH, no menstrual disturbances were reported.

For the antifertility vaccines to be attractive the 1988/89 Biennial Report on Human Reproduction of WHO states that they should 'have long-lasting protective effect after a single course of immunization; they would not cause menstrual-cycle disturbances and other hormone-dependent side effects; they would be easy to administer by a well-accepted procedure; and they could be manufactured at low unit cost.⁴³ Long-lasting was at that time defined as one to two years of protection. Three additional possible advantages were pointed out:⁴⁴ 'The ideal vaccine would not interfere in the process of ovulation and sex-hormone production, in contrast to oral contraceptives which inhibit the hypothalamic-pituitary-gonadal axis. Moreover, immunization would involve the injection of small amounts of the immunogen, in a few doses, sparing the system from constant drugging with synthetic compounds. Vaccines have the advantage of being free from risk of user-failure.

Unlike conventional methods, contraceptive vaccines use the immune system to induce antibodies against hormones or other molecules involved in human reproduction. Although these vaccines can be used both by men and women, most research is directed towards women, as scientists perceive the female cycle to be the easiest target.⁴⁵

Currently six variations of vaccines are at different stages of development. Commonly identified as the most suitable candidates for vaccine development are certain molecules on the surface of the sperm and the egg, molecules on the surface of the fertilized egg and the early human embryo, and the human chorionic gonadotrophin (hCG). If hCG is blocked the level of progesterone declines and the blastocyst is expelled, thereby terminating the pregnancy. Anti-hCG vaccine consists of a part of the hormone linked to a bacterial or viral carrier inducing the antibody reaction. The prototype version of an anti-hCG vaccine consists of an immunogen, formed from a synthetic peptide of hCG conjugated into a toxoid carrier molecule, mixed with an immunostimulant and suspended in a fluid vehicle. A more advanced approach that has reached clinical trial uses vaccines inhibiting the gonadotrophin releasing hormone (GnRH). Recipients need synthetic hormone replacement in order to counteract unwanted side effects such as loss of bone density. In women, a reaction similar to artificial menopause is induced.

It is generally assumed that the final product will be an antifertility vaccine administered by injection or orally and lasting for one or two years.

The following hazards concerning contraceptive vaccines have been suggested:⁴⁵

- Auto immune disorders and cross reactivity.
- Other unexpected side effects: Pain at injection site, fever and sterile abscess formation.
- Women must be screened for pregnancy before immunization and monitored for protective immunity thereafter.
- Reversibility cannot be guaranteed.
- There is a potential for abuse in some of the developing nations facing population pressures.

Miscellaneous

The Central Drug Research Institute, Lucknow, has developed a nonhormonal, nonsteroidal contraceptive by the name Centchroman. It is marketed under the brand name Saheli. Its uniqueness lies in its being a postcoital agent which is taken as a once-a-week tablet instead of continuous administration required with steroidal contraceptives. Less frequent administration of Saheli makes it safer and more economical. Its effect is reversible. It is being produced and marketed by Hindustan Latex Ltd.

Centchroman exhibits its contraceptive efficacy through *embryouterine asynchrony* resulting from: (i) Hastened tubal transport of embryo; (ii) Accelerated blastocyst formation; (iii) Suppression of uterine decidua-lisation and biochemical markers of implantation; (iv) Delayed zona shedding and, most important of all; (v) Inhibition of nidation in the uterus.

Centchroman is supplied in 30 mg tablets. The first tablet should be taken orally on the first day of menstrual period and twice-a-week thereafter, 3 and 4 days apart, on the same day every week for 3 months followed by once-a-week, same day every week, for as long as protection is desired.

In case a tablet is missed, it should be taken as soon as possible and the normal schedule should be continued. As an added precaution, condom should be used.

If a tablet is missed for more than 7 days, the whole schedule should be restarted like a new user, i.e. bi-weekly for first 3 months and weekly thereafter. Centchroman is marketed in India under the trade names Centron 2 and Saheli 2. The pregnancy rate as calculated by Pearl Index was 2.84. The only reported adverse effect was delayed menstruation which occurred in 8 percent of the users.⁴⁶

Based on the limited data available, this novel nonsteroidal chemical may become an extremely important new oral contraceptive. Evidence indicates that Centchroman is highly effective (only 1.63 pregnancies per

100 women in the first year), safe and easy to use and requires no pelvic examination prior to starting the drug. It is free from side-effects and does not delay return of fertility.⁴⁷ The drug also does not appear to cause congenital anomalies in infants born because of user failure.⁴⁸

PRECAUTIONS

- Occasionally, the menstrual cycle is likely to be prolonged in some users but delayed menstruation is of no consequence if tablets have not been missed. However, if the delay exceeds 15 days, the doctor may be consulted to rule out pregnancy.
- In case delay is due to pregnancy, Centchroman should be discontinued immediately.

CONTRAINDICATIONS

- *Absolute:* Recent history of jaundice or liver disease, polycystic ovarian disease, chronic cervicitis or cervical hyperplasia.
- *Others:* Severe allergic conditions, chronic illnesses like tuberculosis and renal disease, and first six months of lactation.

In comparison to hormonal pills, Centchroman is free from several side effects, both minor and common (headache, nausea, soreness of breasts, weight gain, spotting and dizziness) as well as rare and serious (hypertension, thromboembolism and coronary or cerebral infarction). Delayed menses occur only in 8 percent cycles.

National Family Welfare Program

India was one of the first countries in the world to start a national family planning program, officially launched in 1953. Steady progress has been made in this direction since then. The salient features of the program are given below.

The Family Planning Program is being implemented under the Target Free Approach since 1996. This approach has been renamed as Community Needs Assessment Approach since 1997.

Objective

The main objective of the program is to reduce the birth rate. The task of achieving such an objective involves dealing with individuals in delicate matters of their intimate and personal life. The number of married couples, with the wife aged 15 to 44 years, is 170 per 1000 population. As such, for a population of 1000 million, 170 million couples have to be approached to help them plan their families. It has been estimated that if family planning could limit the number of children per couple to 3, 2 or 1, the birth rate would fall to 25, 17 or 9 respectively.

Steps to Achieve the Target and Implement the Program

- Each eligible couple has to be motivated to accept the program in the interest of health and welfare of the family and to meet the dangers of population explosion. The couple should accept the norm of two children.
- Knowledge on methods of contraception and contraceptives should be easily and freely available to eligible couples at their doors, through effective health education and administrative machinery.
- Government and social organizations should take active social measures, conducive to decline in birth rate, such as raising the age of marriage for women, provision of facilities for abortion, sex education to adolescents and adults in schools and colleges and removal of moral and religious taboos, etc.

Motivation of Eligible Couples

An eligible couple is defined as a couple where the wife is within the reproductive age group and where the partners have not adopted terminal methods of family planning, i.e. none of them is sterilised.⁴⁹ The term target couple, used earlier to indicate the priority group for family planning, is not well-defined and has lost its original meaning because of gradual widening of its scope to include even the newly weds.⁵⁰ Eligible couples are approached by health workers by house to house visits in the PHC area. On the average, there are 170 eligible couple per 1000 population. Motivation is also done at dispensaries, clinics and hospitals. Free distribution of contraceptives is done at homes and clinics. Sterilizations are done free in vasectomy and tubectomy camps as also in hospitals. Leave and cash incentives are given for loss of wages and for meeting incidental expenditure. These efforts have resulted in a gradual increase in the proportion of couples resorting to family planning.

Definitions in Family Planning

Some common terms used in relation to the National Family Welfare Program are defined below:⁵¹

CURRENT CONTRACEPTIVE PREVALENCE

Proportion of eligible couples estimated to be currently using a modern contraceptive (estimated to be 56 percent in 2005-06).⁵²

EFFECTIVE CONTRACEPTIVE PREVALENCE

Current contraceptive prevalence adjusted for the relative effectiveness of contraceptive methods (sterilization and oral contraceptives are assumed to be

100 percent effective, IUCDs 95% and conventional contraceptives 50%); always somewhat lower than current prevalence.

TOTAL FERTILITY RATE

The average number of live children that would be born per woman if she were to live to the end of her child-bearing years and bear children according to a given set of age specific fertility rates. The total fertility rate often serves as an estimate of the average number of children per family (estimated to be 2.6 in 2008-09).⁵³

NET REPRODUCTION RATE

The number of live-born daughters a cohort of females would bear under a given fertility schedule and a given set of survival probabilities, from birth to the end of the childbearing years.

It is the only fertility indicator, where mortality rate is taken into account.

MATERNAL MORTALITY RATIO

Number of maternal deaths per 1000 births attributable to pregnancy, childbearing, or puerperal complications (i.e., within six weeks following childbirth). Estimated to be 212/100,000 in 2007-09.⁵³

EQUIVALENT STERILIZATIONS

An index of overall family planning performance calculated by adding the number of sterilizations performed over a period of time, one-third the number of IUCDs inserted, one-eighteenth the number of equivalent conventional contraceptive users (condom, diaphragm, etc.) and one-ninth the number of equivalent oral contraceptive users. These weights are derived from an assessment of numbers of births averted by different contraceptive methods in India.

EQUIVALENT ACCEPTORS

For oral contraceptives and condoms, the numbers of equivalent users are calculated as the number of oral contraceptive cycles distributed divided by 13 and the number of condoms divided by 72; used by the GOI to report achievements for these methods, rather than the numbers of individual acceptors.

POSTPARTUM PROGRAM

The All India Hospitals Postpartum Program, introduced in 1969, is a maternity center/hospital based approach to the family welfare program. The number of postpartum Centers sanctioned up to March, 1984 in medical colleges, district hospitals and maternity hospitals was 554. In addition, 400 centers had been

sanctioned in subdivisional hospitals. The emphasis in the seventh plan is to open more centers of the latter type.

The rationale of PPP is as follows:

- Women who have delivered recently have proven fertility and have a high risk of getting pregnant again.
- They are a “captive audience”. They are more receptive to accept family planning advice at the time of delivery and during the lying-in period.

RESEARCH AND TRAINING

Fifteen Population Research Centers in different places were functioning in 1982-83 with full financial assistance from the Department of Family Welfare. These centers undertake various types of studies, including those on socioeconomic, demographic and communication aspects of population growth and family planning. They also undertake fertility and family planning surveys and studies on fertility differentials, characteristics of family planning acceptors, evaluation of family welfare program, differentials in family planning practices, impact of modernization on fertility, etc.

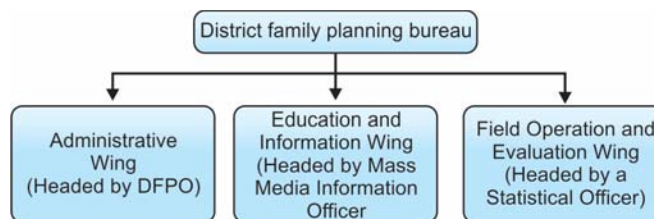
Administrative Set-up

At the center, a separate department of family planning was created in 1966 within the Ministry of Health. In 1977, the ministry was redesignated as Ministry of Health and Family Welfare. There is an Additional Secretary and Commissioner (FW) in this department, along with a Joint Secretary and other staff. The Additional Secretary and Commissioner supervises and coordinates the overall functioning of family welfare activities in different States and Union Territories. The NIHFWS acts as the apex technical institution in family welfare as already mentioned. Three ministerial bodies review the family welfare program from time to time:

1. A Central Family Welfare Council consisting of State Health Ministers.
2. A Population Advisory Council under the Chairmanship of the Central Minister for Health and Family Welfare.
3. A Cabinet Subcommittee headed by the Prime Minister.

At State level, the family welfare work is organized by a State family bureau. It is headed by a State Family Welfare Officer in the Health Directorate. In 1979, it was decided to merge family welfare and malaria eradication programs, creating thereby 17 Regional Offices for Health and Family Welfare in different parts of India.

At District level, the family welfare work is looked after by the District Family Planning Bureau is given in the following diagram.



In the urban areas, there are Urban Family Welfare Centers.

At PHC level, family welfare work is done through a Rural Family Welfare Center. This RFWC, comprising of a medical officer and supporting staff, forms an integral part of the PHC. It provides family welfare services to people in rural areas through the network of subcenters, each of which is staffed by a male and female health worker.

At village level, the family welfare work is done by village health guides and trained *dais*. It may be mentioned that the village health guide scheme has been transferred to the department of family welfare with effect from April 1, 1982. Also, the VHGS scheme, which was earlier a category II scheme (i.e. sponsored by State and Central funds on 50:50 basis), was converted into a 100% centrally sponsored scheme w.e.f. 1-12-1981. This scheme provides for one health guide (preferably a female), selected by the community itself, for every village/every thousand rural population with a view to provide proper care to health needs of the people, particularly in relation to MCH, with special emphasis on propagation and provision of family planning services. The Government of India had introduced in 1975 the Depot Holder Scheme for distribution of condoms to the eligible couples by VHGs. The VHGs would get a cash incentive from the Govt, depending upon the number of condoms distributed. The depot holder scheme, however, failed to function properly.⁵⁴

Budget

The budgetary provisions and investment in family planning over the years are given in **Table 31.4**. The increase in family planning expenditure from 0.1 to 6195 crores over the various plans is truly remarkable.

TABLE 31.4: Family welfare expenditure in various plans

Plan	Expenditure in crores of rupees
I (1951-56)	0.14
II (1956-61)	2.15
III (1961-66)	24.9
IV (1969-74)	278.0
V (1974-79)	409
VI (1980-85)	1425
VII (1985-90)	3105
VIII (1992-97)	6195

Note: Figures for Ninth Plan: 14170 crore

TABLE 31.5: The achievement of the family welfare program

S.no	Indicator	1951	1971	1981	1991	1999
1.	Birth rate	40.8	36.9	33.9	29.5	26.1
2.	Death rate	25.1	14.9	12.5	9.8	8.7
3.	Infant mortality rate	148.0	129	110	80	70
4.	Child (0-4) Mortality rate	NA	51.9	41.2	26.5	23.9 (1996)
5.	Total fertility rate	6.0	5.2	4.5	3.6	3.3 (1997)
6.	Expectation of life at birth					
	(M)	37.1	46.4	54.1	60.6	62.36
	(F)	36.2	44.7	54.7	61.7	63.39

TABLE 31.6: The performance of Family Planning Methods during the last five years

Year	(Figures in Millions)			
	Sterilization	IUD	Condom users	Oral pills users
1995-96	4.42	6.86	17.30	5.00
1996-97	3.87	5.68	17.21	5.25
1997-98	4.24	6.17	16.80	6.39
1998-99	4.18	6.07	17.31	6.87
1999-2000	4.44	6.08	18.70	6.87

Newer Initiatives

Following announcement of the country's population policy in February, 2000, the National Commission on Population was constituted. It was decided to have a National Population Stabilization Fund with a seed money of Rs 100 crore from the Central Government, with support from the corporate sector, NGOs, etc. and an Empowered Action Group, attached to the Ministry of Health and Family Welfare, to give focussed attention to the five States of Uttar Pradesh, Madhya Pradesh, Rajasthan, Bihar and Orissa. The **Empowered Action Group** will be charged with the responsibility of preparing area-specific programs, with special emphasis on States that have been lagging behind in containing population growth to manageable limits and will account for nearly half the country's population in the next two decades.³³

Achievements since inception: Birth rate, death rate and infant mortality rate have declined over the periods. The achievements of the family welfare program have been quite significant as may be seen from the indicators³³ in **Table 31.5**.

Maternal Mortality Ratio (per 1000 live births): 4.37 (1992-93) (NFHS-I); 4.08 (1997) (SRS) 4.07 (1998) (SRS).

PERFORMANCE DURING LAST FIVE YEARS

The performance of Family Planning Methods during the last five years is given in **Table 31.6**.³³

ESSENTIAL OBSTETRIC CARE AND ADDITIONAL ANM IN CATEGORY 'C' DISTRICTS

Essential obstetric care includes those items of obstetric care, which any pregnant woman requires during

normal pregnancy. Many of these inputs are provided by ANM. In category 'C' districts where the status of RCH is poor and the infrastructure, roads and electricity is also generally weak, the task of the ANMs is more difficult. Therefore, in all 'C' category districts of eight states (UP, Bihar, Orissa, MP, Haryana, Assam, Nagaland and Rajasthan), in 30 percent of subcenters, which qualify to be categorized as remote subcenters, one additional ANM, on contractual appointment, is provided under the RCH program.

Reproductive and Child Health Program

On the recommendations of the international conference on population and development held in 1994 at Cairo (Egypt), the Government of India launched the Reproductive and Child Health (RCH) program on 15.10.1997 for implementation during 9th Plan period by integrating and strengthening all the existing interventions under the Child Survival and Safe Motherhood (CSSM) interventions of fertility regulation and adding the component of Reproductive Tract Infection (RTI) and Sexually Transmitted Infections (STI). The concept of RCH Program is to provide need based, client centers, demand driven, high quality and integrated RCH services to the beneficiaries. The program is being implemented on a differential approach basis and in a phased manner.⁵⁶

All the districts of the country have been covered under the program during 1999-2000. The main highlight of the RCH Program are:

- The Program integrates all interventions of fertility regulation, maternal and child health with reproductive health of both men and women.
- The services to be provided will be client centered, demand driven, high quality and need based.
- The program envisages upgradation of the level of facilities for providing various interventions and quality of care. The First Referral Units (FRUs) being set up at subdistrict level will provide comprehensive emergency obstetric and newborn care. Similarly RCH facilities in PHCs will be substantially upgraded.
- It is proposed to improve facilities for obstetric care, MTP and IUD insertion in the PHCs and for IUD insertion in subcenters.

PHN/STAFF NURSES

On the same rationale, the PHCs/CHCs with adequate infrastructure for conducting deliveries will be able to engage PHN/Staff Nurse on contract basis during the project period or till the State Government is able to make a regular arrangement.

HIRING OF PRIVATE ANESTHETIST

Emergency obstetric care is an important intervention for preventing maternal mortality and morbidity. One

of the deficiencies identified for providing emergency obstetric care at FRU is nonavailability of anesthetist for surgical interventions. To tide over the immediate needs, the States have been permitted to engage the anesthetist from the private sector on a payment of Rs 1,000 per case and this facility is available at subdistrict and CHC level but only for emergency obstetric care.

24 HOURS DELIVERY SERVICES AT PHCS/CHCS

Institutional deliveries have beneficial impact on maternal mortality and morbidity as also on the health and well-being of the newborn. One of the reasons demotivating people from seeking deliveries in the health institution is nonavailability of medical/paramedical/cleanliness staffs, especially beyond normal working hours. Therefore, the RCH program has made provision to provide honorarium to the PHC/CHC doctors, nurses and cleaners @ of Rs. 200, 100 and 50 respectively, per delivery, conducted by him/her between 8 pm to 7 pm provided they are not on night shift duty. The program will attempt to set up 24 hours delivery services in CHCs/PHCs in as many districts as becomes feasible. The project will be monitored on the basis of implementation report for individual districts.³³

REFERRAL TRANSPORT TO INDIGENT FAMILIES THROUGH PANCHAYATS

This is sought to be provided in view of the fact that one of the causes of high maternal mortality and morbidity in the weakly performing eight states, particularly in 'C' category districts of these States is weak communication infrastructure and low economic status of many families. Because of this, even if there is a complication identified during pregnancy or delivery, the women have the delivery conducted in the village and frequently by untrained *dais*.

SAFE MOTHERHOOD CONSULTANT

To supplement the regular arrangement, provision have been made for engaging doctors trained in MTP as SM Consultant who will visit to the PHC (including CHCs in NE States) once a week or at least once in a fortnight on a fixed day for performing MTP and other Maternal Health care services.

DAI TRAINING

Reduction in maternal mortality and morbidity is one of the main goals of National Population Policy, 2000. Unsafe deliveries conducted at home by relatives and *dais* are an important cause of maternal mortality and morbidity and most of these *dais* are illiterate, poor and do not have adequate skills in conducting safe deliveries or in identifying high risk among pregnant women during the antenatal period.

THE RCH OUTREACH SERVICES

The RCH household surveys conducted in 252 districts have shown that only 53.5 percent of all children are fully immunized with a range of 16.8 percent in Bihar to 89.5 percent in Tamil Nadu. The situation in the eight large northern and eastern States has been a cause of concern with the coverage for fully immunized children in most of these States being below the national average. Coverage levels for other services also followed similar pattern. For improving the maternal and child health coverage in these States, it has been decided to strengthen outreach services by providing inputs to increase coverage and improve quality of immunization, child health interventions and maternal health services by addressing gaps in service delivery and improving outreach and creating demand through IEC and social mobilization both in urban and rural areas within the districts.

Child Health

Improvement in child health and survival are important aspects of the family welfare program. Low birth weight, diarrheal diseases, acute respiratory infections, vaccine preventable diseases and inadequate maternal and newborn care have been identified as major causes of high infant and child mortality rates in the country. Under the RCH program, interventions like antenatal care, safe deliveries, essential newborn care, immunization against six vaccine preventable diseases, control of deaths due to diarrhea and acute respiratory infections are being implemented. As a result of these interventions deaths due to vaccine preventable diseases have come down significantly.

RECANALIZATION SERVICES (CENTERS OF EXCELLENCE)

This scheme was initiated in 1987 as an UNFPA and AVSC assisted project with Government of India contribution. Under the scheme training is conducted in Standards for Male and Female Sterilization and in Micro-surgical Recanalization. A total of 16 Centers of Excellence were set-up in Medical Colleges in different parts of the country.

SUPPLY OF LAPAROSCOPES AND TUBAL RINGS

In order to ensure quality of laparoscopes and tubal Rings, this Ministry under the Laparoscopic Sterilization Program of Government of India procures and supplies these items to the States/UTs.

TESTING FACILITY AT IIT, NEW DELHI

In order to ensure that quality equipments are utilized in the program, a National Center for testing of IUD and Tubal Rings was set up at the Biomedical Engineering

Wingat IIT, New Delhi, in 1986-87 with financial assistance of UNFPA. With effect from April 1992 onwards the center is being funded entirely by Government of India.

Nonscalpel Vasectomy

Nonscalpel Vasectomy is one of the most effective contraceptive methods available for males. It is more effective than the oral pill or the injectable contraceptive. It is an improvement on the conventional vasectomy with practically no side effects or complications. This new method is now being offered to men who have completed their families, as a special project, on a voluntary basis under the Family Welfare Program. The nonscalpel vasectomy project is being implemented in the country to help men adopt male sterilization and thus promote male participation in the Family Welfare Program.

Involvement of Ngos in the Family Welfare Program

The NGO Division of the Department of Family Welfare is looking after the Mother NGO proposals (received from all over the country) and the innovative projects undertaken by the National NGOs. Apart from these, proposals on Gender Issue Projects are also being processed which are funded by UNFPA. Presently there are 67 MNGOs all over the country spread over 311 districts of 22 States/UTs. It has been planned to cover 450 districts out of 568 (total) by the end of 2000-2001. Under the RCH scheme, out of 57 MNGOs, 24 of them had completed more than a year and their performances have been evaluated by other National NGOs.³³

RCH-IEC ACTIVITIES THROUGH ZILA SAKSHARTA SAMITIS

The Department of Family Welfare in co-ordination with the Department of Education, Ministry of Human Resource Development, has operationalized the initiative to have District level IEC, relating to RCH and Population Control through Zila Saksharta Samitis (ZSS). The Literacy Program has substantially succeeded in mobilizing masses and this strategy of integrating Family Welfare with Literacy Program is expected to be effective.

VILLAGE HEALTH GUIDE SCHEMES

The Scheme was started in 1977 as the 100 percent Centrally sponsored Scheme with the basic objective of providing Primary Health Care at the doorsteps of the people.

POSTPARTUM PROGRAM

At present postpartum program is being implemented in 550 District level and 1012 subdistrict level institutions

in the country. It functions at referral center for Peripheral Institutions. It ensures effective obstetric services leading to decline in infant and maternal mortality and better acceptance of family planning methods. The Postpartum Program both at district and subdistrict level are under plan scheme and 100 percent centrally funded. This assistance is provided to States for implementation of the Program, i.e. for funding expenditure like salary of staff, maintenance of Postpartum Ward and Operation Theatre, POL, etc.

URBAN REVAMPING SCHEME AND URBAN FAMILY WELFARE CENTER

The Urban Family Welfare Center and Health Posts provide comprehensive RCH Services with focus on outreach services. The referral support for these centers is provided by the nearest hospital/postpartum centers. These centers are envisaged to function in close coordination with ICDS (Anganwadis) and Urban Basic Centers in their respective areas.

STERILIZATION BED SCHEME

A Scheme for reservation of sterilization beds in hospitals run by Government, Lok Bodies and Voluntary Organization was introduced in 1964 in order to provide immediate facilities for tubectomy operations in hospitals where such cases could not be admitted due to lack of availability of beds, etc. At present beds are being sanctioned to hospitals run by Local Bodies and Voluntary Organizations. These organizations are provided grant-in-aid as per approved pattern of assistance.

COMMUNITY NEEDS ASSESSMENT APPROACH (CNAAP)

The Family Welfare Program is now being implemented on the basis of Community Needs Assessment Approach (CNAAP) with effect from April 1996. Under this approach, the practice of fixing targets from above was given up. Now, all the States and Union Territories in the beginning of the year will prepare the District/State level family welfare and health care plans by assessing the service needs of the community for planning qualitative services. This ensures community for planning qualitative services. This ensures community's involvement in the program. All the States/Union Territories are to send monthly performance reports from district level to State and National level through NICNET network. The CNAAP has been proposed to be strengthened through involvement of communities in monitoring the proposed results. Thus CNAAP will be renamed as **Community Needs Assessment and Monitoring Approach (CNAMA)**.

POPULATION RESEARCH CENTERS

The Union Ministry of Health and Family Welfare have established a network of 18 Population Research

Centers (PRCs) in various Universities (12) and other Institutions (6) of national repute, scattered over 17 major States of India on the basis of facilities and other infrastructure available. These Centers are responsible for carrying out research on various topics of Population Stabilization, Demographic and Sociodemographic Surveys and Communication aspects of Population and Family Welfare Program.

RAPID HOUSEHOLD (DISTRICT LEVEL) SURVEY

In order to make critical assessment of the health services provided by the State Governments under RCH program, an important survey called Rapid Household Survey (RHS) is being conducted since 1998 in 50 percent districts of each State/UT. The first phase of the RHS was conducted within a very short time from October, 98 to December, 98 in 50 percent districts of each of the 32 States/UTs. Second phase of RHS covering the remaining 50 percent Districts have also been completed in 1999.

FACILITY SURVEY

To assess availability and utilization of facilities in various health institutions all over the country, District-wise facility survey was conducted during 1998-99. Although it was proposed to start these surveys from July 1998, it was started only in December, 1998.

NATIONAL FAMILY HEALTH SURVEY⁵²

The National Family Health Surveys (NFHS) are nationwide surveys conducted with a representative sample of households throughout the country, under the Ministry of Health and Family Welfare, Government of India. The three NFHS surveys conducted to date are a major landmark in the development of a demographic and health data base for India. The NFHS surveys use standardized questionnaires, sample designs, and field procedures to collect data. The information provided by NFHS surveys assists policymakers and programme administrators in planning and implementing population, health, and nutrition programmes. The MOHFW designated the International Institute for Population Sciences (IIPS), Mumbai, as the nodal agency for each of the three rounds of NFHS.

Each round of NFHS has had **two specific goals:** a) to provide essential state and national level data to monitor health and family welfare programmes and policies implemented by the Ministry of Health and Family Welfare and other ministries and agencies, and b) to provide information on important emerging health and family welfare issues.

The **Third National Family Health Survey (NFHS-3)** was conducted in 2005-06. As did NFHS-1

(1992-93) and NFHS-2 (1998-99), NFHS-3 provides information on fertility, mortality, family planning, HIV-related knowledge, and important aspects of nutrition, health, and health care. Unlike the earlier surveys, however, NFHS-3 interviewed men age 15 to 54 and never married women age 15 to 49, as well as ever-married women, and included questions on several emerging issues such as perinatal mortality, male involvement in maternal health care, adolescent reproductive health, higher-risk sexual behavior, family life education, safe injections, and knowledge about tuberculosis. In addition, NFHS-3 carried out blood testing for HIV to provide, for the first time in India, population-based data on HIV prevalence.

NFHS-3 collected information about all usual residents as well as visitors who stayed in the selected households the night before the household interview. Those who stayed in the household on the night before the household interview, be they usual residents or visitors, together form the **de facto** population. Usual residents, whether they stayed in the household on the previous night or not, form the **de jure** population. The de facto and de jure populations differ from each other as a result of temporary population movements. In NFHS-3, most of the things are based on the **de facto** population.

NFHS-3 used three types of questionnaires: the Household Questionnaire, the Women's Questionnaire, and the Men's Questionnaire. NFHS-3 collected information from a nationally representative sample of 109,041 households, 124,385 women age 15 to 49, and 74,369 men age 15 to 54. The NFHS-3 sample covers 99 percent of India's population living in all 29 states. HIV seropositivity and blood hemoglobin level were also tested.

Salient Findings of NFHS-3⁵²

- Thirty-five percent of the population is under age 15, and only 5 percent is aged 65 years and older. Over two-thirds (69 percent) of the population lives in rural areas.
- Based on the religion of the household head, 82 percent of households are Hindu, 13 percent are Muslim, 3 percent are Christian, 2 percent are Sikh and 1 percent are Buddhist/Neo-Buddhist.
- NFHS-3 finds the sex ratio of the population age 0 to 6 years (girls per 1,000 boys) to be 918 for India as a whole.
- Seventy-two percent of children of primary-school age attend primary school and 51 percent of secondary-school age children attend secondary school.
- Sixty-eight percent of households in India now have electricity. Most households (88%) have access to an improved source of drinking water, with greater

- access in urban areas. The most common improved source of drinking water for urban dwellers is piped water. Nationally, 45 percent of households have any toilet facilities. Forty-six percent of households live in a *pucca* house.
- Just over half (55%) of de facto women aged 15 to 49 years are literate, compared with 78 percent of de facto men in the same age group. Literacy has increased substantially over time.
 - More than half of women are married before the legal minimum age of 18. Among women age 20 to 49, the median age at first marriage is 17.2 years.
 - Fertility continues to decline in India. The current total fertility rate (TFR) is 2.7 (TFR 2.9 in NFHS-2). But it is still well above the replacement level of just over two children per woman. In urban areas, the TFR has reached replacement levels (2.1), but in rural areas the TFR is 3.0.
 - Knowledge of contraception is nearly universal: 98 percent of women and 99 percent of men age 15 to 49 know one or more methods of contraception. The contraceptive prevalence rate for currently married women in India is 56 percent (48% in NFHS-2). Unmet need for family planning among currently married women is 13 percent (16% in NFHS-2).
 - The NFHS-3 estimate of infant mortality is 57 deaths per 1,000 live births (68 deaths per 1,000 live births in NFHS-2). The perinatal mortality rate, which includes stillbirths and very early infant deaths (in the first week of life), is estimated at 49 deaths per 1,000 pregnancies that lasted 7 months or more for the 2001-05 period.
 - Although 76 percent of women who had a live birth in the five years preceding the survey received antenatal care, only 44 percent started antenatal care during the first trimester of pregnancy, as recommended. Thirty-nine percent of births in the five years preceding the survey took place in health facilities; more than half took place in the woman's own home; and 9 percent took place in parents' homes.
 - Nationally, 72 percent of the NFHS-3 sample enumeration areas were found to be covered by an AWC and 62 percent were covered by an AWC that had, by the time of the survey, existed for at least five years.
 - Only one-quarter of last-born children who were ever breastfed started breastfeeding within half an hour of birth, as is recommended, and almost half (45%) did not start breastfeeding within one day of birth. At age 6 to 8 months, only about half of children (53%) are given timely complementary feeding (breast milk and complementary food). Almost half of children under five years of age (48%) are stunted and 43 percent are underweight.
 - In India, only 44 percent of children age 12 to 23 months are fully vaccinated, and 5 percent have not received any vaccinations.
 - More than one-third (36 and 34% of women and men respectively) aged 15 to 49 years having BMI below 18.5, indicating chronic nutritional deficiency. Anemia affects 55 percent of women and 24 percent of men. Approximately half of households (51 percent) were using sufficiently iodized salt at the time of the survey. About 57 percent of men, compared with 11 percent of women use some form of tobacco in the age group 15 to 49 years.
 - Nationwide, only 17 percent of women and 33 percent of men have 'comprehensive knowledge' of HIV/AIDS. 'Comprehensive knowledge' means they know that a healthy-looking person can have HIV, that HIV/AIDS cannot be transmitted through mosquito bites or by sharing food, and that condom use and fidelity help prevent HIV/AIDS. Nationwide, the HIV prevalence rate for the population age 15 to 49 is 0.28 percent (0.22% in women and 0.36% in men).
 - Regarding family life education, all Indian adults agree that children should be taught moral values in school, and a large majority also agree that children should be taught in school about the changes that occur during puberty.
 - Only 37 percent of currently married women participate (make the decision alone or jointly with their husband) in making all four decisions.
 - More than a third (34%) of women age 15 to 49 have experienced physical violence, and 9 percent have experienced sexual violence. In all, 35 percent of women age 15 to 49 in India have experienced physical or sexual violence.

National Population Policy

A new National Population Policy has been approved by the Cabinet in its meeting held on 15th February, 2000. The Policy aims at the following objectives:

Short-term

The immediate objective of the National Population Policy is to address the unmet needs of contraception, health infrastructure, health personnel and to provide integrated service delivery for basic reproductive and child health care.

Medium-term

The medium term objective is to bring the total fertility rates to replacement level by 2010, through vigorous implementation of intersectoral operational strategies.

Long-term

The long-term objective is to achieve a stable population by 2045, at a level consistent with the requirements of sustainable economic growth, social development and environmental protection.

The policy states the following national socio-demographic goals to be achieved by 2010:

- Address the unmet needs for basic reproductive and child health services, supplies and infrastructure.
 - Make school education up to age 14 free and compulsory, and reduce dropouts at primary and secondary levels to below 20 percent for both boys and girls.
 - Reduce infant mortality rate to below 30 per 1000.
 - Reduce maternal mortality ratio to below 100 per 100,000 live births.
 - Achieve universal immunization of children against all vaccine preventable diseases.
 - Promote delayed marriage for girls, not earlier than age 18 and preferably after 20 years of age.
 - Achieve 80 percent institutional deliveries and 100 percent deliveries by trained persons.
 - Achieve universal access to information/counseling, and services for fertility regulation and contraception with a wide basket of choices.
 - Achieve 100 percent registration of births, deaths, marriage and pregnancy.
 - Contain the spread of acquired immunodeficiency syndrome, and promote greater integration between the management of reproductive tract infections (RTI), and sexually transmitted infections (STI) and the National AIDS Control Organization.
 - Prevent and control communicable diseases.
 - Integrate Indian System of Medicine (ISM) in the provision of reproductive and child health services, and in reaching out to house holds.
 - Promote vigorously the small family norm to achieve replacement levels of TFR.
 - Bring about convergence in implementation of related social sector programs so that family welfare becomes a people centered program.
- For achieving these goals the following strategies have been formulated:
- Panchayats and Zila Parishads will be rewarded and honoured for exemplary performance in universalising the small family norm, achieving reductions in infant mortality and birth rates, and promoting literacy with completion of primary schooling.
 - The Balika Samridhi Yojana run by the Department of Women and Child Development, to promote survival and care of the girl child, will continue. A cash incentive of Rs 500 is awarded at the birth of the girl child of birth order 1 or 2.
 - Maternity Benefit Scheme run by the Department of Rural Development will continue. A cash incentive of Rs 500 is awarded to mothers who have their first child after 19 years of age, for birth of the first or second child only. Disbursement of the cash award will in future be linked to compliance with antenatal check up, institutional delivery by trained birth attendant, registration of birth and BCG immunization.
 - A Family Welfare-linked Health Insurance Plan will be established. Couples below the poverty line, who undergo sterilization with not more than two living children, would become eligible (along with children) for health insurance (for hospitalisation) not exceeding Rs 5000, and a personal accident insurance cover for the spouse undergoing sterilization.
 - Couples below the poverty line, who marry after the legal age of marriage, register the marriage, have their first child after the mother reaches the age of 21, accept the small family norm, and adopt a terminal method after birth of the second child, will be rewarded.
 - A revolving fund will be set up for income-generating activities by village-level self-help groups, who provide community-level health care services.
 - Creches and child care centers will be opened in rural areas and urban slums. This will facilitate and promote participation of women in paid employment.
 - A wider, affordable choice of contraceptives will be made accessible at diverse delivery points, with counseling services to enable acceptors to exercise voluntary and informed consent.
 - Facilities for safe abortion will be strengthened and expanded.
 - Products and services will be made affordable through innovative social marketing schemes.
 - Local entrepreneurs at village levels will be provided soft loans and encouraged to run ambulance services to supplement the existing arrangements for referral transportation.
 - Increased vocational training schemes for girls, leading to self-employment will be encouraged.
 - Strict enforcement of Child Marriage Restraint Act, 1976.
 - Strict enforcement of the prenatal Diagnostic Techniques Act, 1994.
 - Soft loans will be increased (To ensure mobility of the ANMs).
 - The 42nd Constitutional Amendment has frozen the number of representatives in the Lok Sabha (on the basis of population) at 1971 Census levels. The freeze is currently valid until 2001, and has served as an incentive for State Governments to fearlessly pursue the agenda for population stabilisation. The freeze needs to be extended until 2026.

Nongovernmental Organizations (NGOs)

The work through the NGOs is not by way of alternative to work through a Government system, it is actually complementary in nature. Both sectors have their own strong points which cannot be ignored and therefore, both the Government Sector and the NGOs should be used in complementary manner for optimum effect. The NGOs have the advantage of flexibility in procedures, rapport with local population and credibility. They are therefore, better placed to try innovations which the Government system is not in a position to even attempt. The Department of Family Welfare has been increasing the involvement of NGOs over the years and currently about 600 NGOs are being assisted for various Programs. The main thrust of the NGO Program in the 9th Plan will be to involve NGOs essentially in innovative programs and not to use them for implementing routine Government Programs. Also the NGO Program will be so directed as to not burden the Department of Family Welfare with all the NGO cases of the country which obviously the Department cannot deal with efficiently.

INPUTS

In view of the above mentioned policy thrusts, the following NGO Programs would be implemented in the 9th Plan.

Small NGOs

- At the village, Panchayat and Block levels, small NGOs will be involved basically for advocacy of RCH and Family Welfare Practices and for counseling to explain the facts and consequences of using or not using RCH/Family Welfare Practices. However, the individual NGOs at this level will be allowed to propose innovative programs also and these will be considered for sanction if they are found practicable by Mother NGO.
- These small NGOs have small resources and they should not in fairness be asked to send their proposals all the way up to Central Government or to come to Delhi. Therefore, assistance to such small NGOs will be organized through Mother NGOs each for 5 to 10 Districts.

Mother NGOs

- Mother NGOs with substantial resources and proved competence will be approved. They will be given grants by the Department directly once in a year at the beginning of the year. In subsequent years the annual grant will be given after taking into consideration the performance report for the previous year and utilization certificate for the grants given earlier.
- The Mother NGO will have one nominee of the State Government and one of the Government of India

on its Executive Committee. They will screen the credentials of the applicant small NGO, obtain proposal from it, consider it for sanction, release money to it, monitor its work and obtain utilization certificate from the small NGO. The nominee of the State/Central Governments must be present while sanctioning the Projects otherwise such sanctions may not be valid.

- The Mother NGO will also provide training to the staff of the small NGOs for both management of the NGO and for management of the Programs.
- The Mother NGO will furnish Annual Report and its audited accounts to the Department every year mentioning the work done by each NGO during the year and the result of periodic verification done by the Mother NGO in the field of the work of small NGOs while claiming grant for the next year.
- In order to facilitate easy working, it has been decided that there will be no insistence on any share being contributed for implementation of the Program by the small NGO or the Mother NGO. Also the annual grant to all NGOs will be released in one annual installment because the system of two installments in the year has been found to be impracticable.
- While sanction to small NGO by the Mother NGO will be for the needs of the Program, the sanction to the Mother NGO by the Department of Family Welfare will be to the extent of financing done by the Mother NGO to the small NGO plus 20 percent of such financing by way of institutional overheads of the Mother NGO and for providing support services to the small NGOs.
- No mother NGO would be expected to sanction a project to itself for implementation. This applies to any branch or affiliated office of the Mother NGO as well. However, in few cases, if some branch of the National or Mother NGO submit the project for implementation, the same would be got verified from other National/Mother NGO and the project will be sanctioned if all necessary conditions are fulfilled by that branch independently for being a suitable NGO.
- Annual funds required by a Mother NGOs will be released on quarterly/six-monthly basis and will be based on their performance.

National NGOs

- A limited number of national level NGOs will be assisted by the Department on project basis for innovative Programs. Again, the attempt will be not to involve the NGOs in repeating the Government Programs. In addition to above mentioned general categories or NGO Programs, the Department proposes to involve NGOs for some specific areas wherever involvement is expected to yield good

results. For example, for introducing Baby-friendly practices in hospitals it is proposed to give projects for individual hospitals in cities to individual NGOs. Similarly for helping in enforcement of Prenatal Diagnostic Technique Act by detecting offending sex determination clinics and collecting evidences for making specific complaints against them to the designated authorities in the States, it is proposed to involve a number of NGOs in different parts of the country.

- A limited number of NGOs may be assisted for mobile clinics having equipped vans offering RCH and spacing methods services including IUD insertions. These clinics will operate in identified areas and visit villages on fixed days of the week or fortnight. The cost of vans, drugs, a lady medical officer and a paramedical worker will be funded under the program. Initially these clinics will be operationalized at 10 places in the country and extended later based on the experience gained from the projects.
- A large number of hospitals and clinics have come up and are coming up in urban areas which unfortunately are so far not setting adequately involved in offering facility for contraceptive/terminal methods and for counseling both in regard to RCH and population control measures. The desirability of involving the hospitals/clinics in non-government sector in these activities is obvious. It is proposed to motivate such hospitals/clinics for setting up the above mentioned units by offering them a token one time start-up assistance of not more than Rs 2 lakh after which they will be expected to maintain these services in any case for not less than 5 years.
- A small number (6–8) of national level NGOs/institutions will be selected to make verification of credentials of Mother NGOs. Apart from the verification of Mother NGOs, National level NGOs may also be assigned the work of the assessing the performance of some of the Mother NGOs on a regular basis.

PROCEDURE FOR SANCTION/CONDITIONS REGULATING ASSISTANCE

- The following conditions will apply to small NGOs and Mother NGOs: NGO should have the character of a registered society or trust or nonprofit making company. NGO should have been in existence preferably for at least 3 years but this can be considered for being waived in areas which are weak in NGO coverage. NGO must have office premises either its own or rented. There should be at least minimum necessary furniture and office equipment. NGO should have at least one full time or part time specialist relating to field of activity and at least one full time/part time person for administration/financial management. The Government Body of NGO must have at least 35 percent members with background in the field of activity. National and Mother NGOs must have at least Rs 1 lakh in fixed/cash assets to ensure that it is an organization of substance. For field level small NGOs this would be to the extent of Rs 25,000/-. Before the first project is assigned to the NGO its credentials and assets must be verified by an independent agency to establish its bonafides. An NGO blacklisted by any Ministry/Department of GOI would not be sanctioned a project by the Department for next 5 years. The NGO should have already existing premises/office in the state where it wishes to work.
- It will be the responsibility of the Mother NGOs to verify fulfillment of these conditions and to keep a record of the verification made for being made available to the Department of Family on demand.
- In the case of Mother NGOs, the Department of Family Welfare will have their antecedents and credentials verified through a national level NGO before according it the status of Mother NGO and before sanctioning any project to it.
- For this purpose, the Department of Family Welfare will enter into an arrangement with one or more national level NGOs like SOSVA or Voluntary Health Association of India or Family Planning Association of India, etc. by agreeing to pay to those national level NGOs for every verification report. Therefore, at the time of first application the sanction to the Mother NGO is likely to take three months after the application is received in the Department.
- A limited number of national level NGOs will be assisted by the Department on project basis for innovative programs. Again, the attempt will be not to involve the NGOs in repeating the Government programs. The conditions specified for small and Mother NGOs will apply to the national level NGOs also. Although many of the national level NGOs have established credentials but the NGOs which have not earlier worked for the Department may be subjected to verification through an identified national level NGO before a project is sanctioned to it. All such sanctions to national level NGOs will be on project basis which will be generally for 3 to 4 years. Each project will be for a well-defined area with stated objectives to be attained at the end of the project. While the sanction under the individual projects will vary depending on the nature of the project but generally an upper limit of Rs 50 lakh for a 3 years project will be observed.
- All NGO cases at the central level will be considered for sanction by a committee headed by the Secretary, Department of Family Welfare and will include in addition to the Program Joint Secretary and Financial Advisor of the Department, two NGO representatives, three RCH specialists and representative of

the planning commission. The committee will meet at least every quarter and will consider cases which have been received up to that stage.

- The effectiveness of the NGO projects in the area of counseling and advocacy will be assessed on the basis of the improvement in increased CPR, sterilizations and other project related goals. Similarly, while evaluating the performance of national level NGOs and Mother NGOs, their effectiveness will be judged on the same criterion.³³

Social Dimensions of Family Planning and Population Control

It has been rightly said that development is the best contraceptive, meaning thereby that fertility rates come down as development proceeds. Three major deterrents to development are illiteracy, poverty and social inequality and injustice. Out of these, illiteracy is probably most important from the point of view of family planning. The two major strategies to contain population growth are family planning and education.

Female literacy is of crucial importance in the context of family planning. According to the 1984 World Development Report, “*More education for women is one of the strongest factors in reducing fertility*”. Surveys in all countries show that women who have completed primary school have fewer children than those who have had no education. This gradient is maintained as we go up the higher educational levels. Successful total literacy campaigns in various states have been accompanied by remarkable additional benefits in the field of family planning. The example of Kerala, the first fully literate state, is well known. The latest example is that of Karnataka. In the districts of Mandya, Tumkur and Shimoga, Total Literacy Campaigns have done in a few years what the National Program of Family Planning could not achieve over decades. The reasons are not far to seek. The Family Planning Program is beset by bureaucracy, employs a large workforce of 11 million and spends millions of rupees on stale and ineffectual propaganda. Moreover, the political will to implement the family planning program lacks on the part of politicians who have their eyes on vote banks. Also, the program is target-oriented and quantitative, shows a strong bias for sterilizing women of 35 plus who have already borne four to five children, and ignores the needs of adolescents and younger women.

In contrast, the total literacy campaign aims to create motivation and mobilization through thousands of volunteers working at grassroots level. It is a people-oriented and participatory program, whose campaign is managed by the area Sikshaartha Society, a voluntary agency comprising officials, volunteers, learners and local nongovernmental organizations (NGOs). Suprisingly,

the volunteers work without honorarium for the entire campaign period spanning 18 months to two years.

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School health is an important aspect of any community health program. The school health program is a powerful, yet economical approach towards raising the level of community health. Its basic aim is to provide a comprehensive health care program for children of school going age.¹

It would be more correct to use the term 'Health Care of School Age Children' rather than School Health. The former term indicates that school health is not something new in itself but rather a part of the overall community plan for child health, which should begin in the prenatal period and continue throughout childhood up to the school years.

School health services are not well organized in our country, especially in the rural areas. School health services tend to be neglected since morbidity and mortality are comparatively much lower at school age than in the preschool years and other periods of life. In the West, the importance of this service was recognized when deficiencies in health status were found in soldiers at the time of recruitment for the First World War. These deficiencies were noticed too late for correction but would have been remedied easily if they had been detected and treated during the school period.

Health Status of School Children

Health surveys in Indian schools indicate that morbidity and mortality rates of children are among the highest in the world. Morbidity of school children has been studied in small surveys in Tamil Nadu,^{2,3} Kerala,⁴ Andhra Pradesh,⁵ Madhya Pradesh,⁶ Punjab,⁷ and Delhi.⁸ Most of these surveys yielded more or less similar findings, the general prevalence of morbidity being as follows:⁹

Dental ailments	70-90%
Malnutrition	40-75%
Worm infestations	20-40%
Skin diseases	10%
Eye diseases	4-8%
Pulmonary TB	4-5%

In addition to the above, diseases of cardiovascular, respiratory, gastrointestinal and urogenital systems were also detected to varying extent in different surveys, ranging

from less than 1 percent to around 10 percent. Hardly more than 40 percent of the school children are found to be reasonably healthy and free from defects.⁹ An evaluation of the School Health Program in 9 PHCs by the NIHFWS showed that 24 percent of the school children medically examined had some disease or defect. Eleven percent of those found to have such defect had to be referred to a specialist.¹⁰

School Health Service in India

No authentic records are available in India regarding initiation of these services. Way back in 1909, medical examination of school children is reported to have been carried out in Baroda city for the first time in India. The Health Survey and Development Committee (popularly known as the Bhore Committee) in 1946 noted that school Health Services were practically nonexistent in India.¹¹ In 1960, the Government of India constituted a School Health Committee to assess the standards of health and nutrition of school children. This Committee was also assigned the task of suggesting ways and means to improve the health status of school going children. In 1961, this Committee submitted its report which contained many useful suggestions and recommendations.

In view of the crucial importance of school health, and the grossly inadequate inputs in it, the Government of India constituted a Task Force to propose an Intensive School Health Service Project which could be implemented on a trial basis. The Task Force submitted its report⁹ in Jan 1982. According to this report, only 14 of the 22 states had made efforts at establishing a school Health Program through their own health budgets. The program covered only 1337 out of total 3614 PHCs in these states. Even in these States, the response and performance has not been encouraging. The Task Force identified the following reasons for the poor state of school health program:

- Lack of transport facilities for the PHC medical officer
- Lack of budget for printing health cards, etc.
- Lack of properly trained school teachers, multi-purpose workers, and other education and health personnel who can ensure effective functioning of the school health program.

- Lack of proper documentation and evaluation.
- Lack of coordination between:
 - Different schemes and health programs within the health department.
 - Health department and outside agencies, particularly the education department.

The Task Force suggested that an *Intensive Pilot Project*, fully sponsored by the Central Government, should be started on an experimental basis in 25 blocks in the country. Choosing a block from the remote and underdeveloped areas of different States and Union Territories, the pilot project was started in the year 1982-83. During the year 1984-85, it was extended to 75 more blocks.

An evaluation of the Intensive Pilot School Health Project was undertaken by the NIHF. It made the following *suggestions for the improvement of School Health Program* in order of priority:¹⁰

- School health education needs to be intensified.
- School buildings and school sanitation need to be improved.
- Nutritional status of primary school children should be improved through midday meal program, providing 50 percent of daily energy requirement and 30 percent of daily protein requirement.
- Immunization services should be provided to ensure that the following goals are reached:
 - 85 percent coverage of children in class I in relation to DT and typhoid immunization.
 - 100 percent coverage of children in class VI and X as regards TT.
- Arrangements should be made for medical examination of children and provision of treatment for the morbidity detected. The guiding principle should be that no medical examinations should be conducted unless a system of referral and follow-up has been organized.

The Central Government's School Health Project is a step in the right direction, but it suffers from the major drawback that it is essentially a project of the Health Department, there being very little coordination with the Education Department. In contrast, the comparatively much more successful ICDS, though essentially an MCH activity, is a project of the Department of Women and Child Development with active technical support from the health sector.¹²

Special Needs of the School Child

The school age is a formative period, physically as well as mentally, transforming the school child into a promising adult. Health habits formed at this stage will be carried to the adult age, old age and even to the next generation. Thus school health service is a forum for the improvement of the health of the nation.

There are *two special needs in school years*:

1. *Health guidance*: Children are continuously undergoing change—physical, mental, emotional and social. In the absence of such guidance, their growth and development may be affected.
2. *Education in group-living*: The child plays, travels and learns things with others. He has to learn to adjust and adapt to school environment, which is quite different from that at home.

School Health Program

Objectives¹

- Health consciousness among school children.
- Providing health instruction in a healthy environment.
- Prevention of disease; early diagnosis, treatment and follow-up of defects.
- Promotion of positive health.
- Recognising the child as a “change-agent” in the family.

Components

The school health program has three major components: Health education, healthy environment and health service.

HEALTH TEACHING AND HEALTH EDUCATION

This is the most important element of a school health program. It does not merely imply inclusion of health lessons in the textbooks but also includes the following:

- Insisting on high standards of cleanliness in the school.
- Improving water supplies and latrines and inculcating habits for their proper use.
- Introducing healthy practical diets into the school lunch program.
- Demonstrating personal hygiene, such as cutting of nails, dressing of hair, bathing with soap and water, etc.

Visits to observe community health problems should be arranged and opportunities for actual participation in health projects and tasks should be provided. In developing countries, *every school child should be considered a health worker*. School age children constitute an easily accessible and adaptable segment of the population. They can contribute much towards attack on community health problems. They take home to parents all the instructions on health that they receive at school and can, in fact, act as health leaders in the family.¹³ Even more important, they apply this knowledge to their own families when they become adults.

The teacher plays a very vital role in all elements of the school health program, especially in health education. Efforts should be made to strengthen the health

content of teacher training courses by including such subjects as growth and development of children, nutrition, control of communicable diseases and mental health.

MAINTENANCE OF HEALTH GIVING ENVIRONMENT

This should include not only the sanitation of the school premises but also the surroundings, which have moral, physical and mental effect on the school child. The site should be carefully selected. It should be dry, on raised ground, situated at a distance from the road so as to minimize the nuisance of dust, noise and too much traffic.

Proper maintenance of the school building is even more important than the site and actual construction. The medical officer or sanitary inspector should advise school authorities on different items of sanitation as below:

Water Supply

If tap water is not available and the source of water is a well, proper chlorination of the well should be ensured. Also, water for drinking should be available to children in a proper container with a tap and a glass. In case of earthenware containers, a ladle must be provided. Each student should learn to drink water either directly from the tap or by pouring it into the mouth from a glass.

Drainage

The waste water should drain into a soakpit or a garden.

Urinals

They are absolutely necessary. Cheap soakpit or trench type urinals can be provided in rural schools. The habit of passing urine anywhere should be curbed.

Latrines

Each school must have a latrine. The provision of a latrine in rural schools, besides being desirable for other reasons, is also a source of practical education to children in appreciating the need for proper disposal of excreta.

Refuse

Each room should have a refuse basket to be emptied into a compostpit. The rooms should be swept and cleaned and all dust, paper and other refuse should be collected into the basket. The refuse may also be disposed of by burning.

Ventilation

Enough windows, doors and ventilators should be provided to admit fresh air and light. Good light and

ventilation and other items of environmental sanitation promote physical and mental health. Sanitary and civic sense, learnt at school, is carried home and thus becomes a habit.

Playground

It is a must for recreation and physical education.

COMPREHENSIVE HEALTH CARE

It should be promotive, protective and curative, as well as rehabilitative.

Health Promotion

Health is promoted through environmental sanitation and health education as discussed above, and by good nutrition, recreation, exercise and personal hygiene. Nutrition plays a very vital role in physical growth and development of the school child. Poor nutrition affects education achievement as well. The relationship between scholastic performance and nutritional status of children has been established.¹⁴ A midday meal helps in supplementing nutritional intake of school children.

Physical exercise and activities in the school promote musculoskeletal development and inculcate team spirit. Promotion of mental health can be facilitated by school teachers. Because of direct contact with students, they can help in release of mental tension.

Health Protection

It should be done through environmental sanitation, nutrition, immunization and guidance about safety against accidents (especially those on the road, by instilling traffic sense).

Curative Services

They include regular medical check-up and preparation of health cards; prompt treatment of defects; follow-up; and referral for special problems.

Medical check-up: The Medical Officer should carry out a detailed examination of each child in the school and should fill the school health card. He may be assisted by a school health assistant or a teacher for recording general and family history, weight and height, etc. A minimum of three examinations should be carried out as follows:

- On school entry at the age of 5 to 6 years.
- On passing out from primary school at age 10 to 11 years.
- On passing out from middle school at age 13 to 14 years.

In addition, periodic (twice a year) testing of weight, height, vision and hearing may be done by health auxiliaries and teachers oriented towards school health. Daily observations made by the class

teacher are also very useful in detecting any deviations from normal health.

Treatment: Minor ailments may be treated at school. All defects should be treated at the central school health clinic or at the PHC or dispensary. Expert help for diagnosis and treatment should be made available.

Follow-up of cases with defects must be done and the parents should be informed about it.

Special Problems

- **Teeth** services of a full or part-time dentist should be available. Dental health education and knowledge about caries and gingivitis should be imparted.
- **Eyes** defective vision and squint need the services of a specialist who should prescribe glasses and treat squint.
- **Ears** wax, discharge and hearing defects should be attended to.
- **Communicable diseases:** These should be promptly treated and also notified for mass measures, if necessary. Examples of important communicable diseases are leprosy, tuberculosis, diphtheria, scabies, ring worm, etc.

Rehabilitative Care

Handicapped children need special care. The handicap may be:

- **Physical**, such as serious heart disease, high myopia, partial or complete blindness, deafness, deaf-mutism, stammering and crippling of body or limbs
- **Mental**, such as subnormal intelligence, mental deficiency, epilepsy or delinquency.

Those with marked defects should be trained in special institutions and rehabilitated. Those with minor defects may be kept in the normal schools. However,

their teachers should be instructed to pay special attention to them.

HOW TO START A SCHOOL HEALTH PROGRAM¹

- Step 1: Organize the principals of the schools.
- Step 2: Motivate and involve the teachers.
- Step 3: Provide health education to teachers.
- Step 4: Develop resource materials and child-to-child activities.
- Step 5: Implement the program. It is essential to form a coordinating health committee for this purpose, consisting of the principal, teachers, community leaders, parents and children.

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Geriatrics: Care and Welfare of the Aged

World Health Day 2012: Aging and Health

The average length of human life has increased over the centuries as living conditions have improved and childhood mortality has fallen.¹ The maximum lifespan of our species is determined largely by our genes and will be the same as it ever was.¹ The only debate is whether and how this optimal genetic potential can be realized.

Gerontology is the science of aging while geriatrics refers specifically to the problems associated with aging. The word “geriatrics” was coined by Ignatz L Nascher in 1909.² Nascher’s initiative provided a stimulus for social and biological research on aging.³ If Nascher was the father of geriatrics, Majority Warren was its mother. For the first time in 1935 she established a special geriatric unit in England.⁴

The care of the elderly is drawing more and more attention of the government and the public. It is already a major social and health problem in affluent countries. Like pediatrics, it deals with an age group that has high morbidity and mortality. It is ironical that while science has prolonged life, the changes that it has brought about in cultural and social patterns have robbed the elderly of their status and self-esteem and have deprived them of chance to function usefully in the society.

Aging involves two opposing type of changes, evolution or growth, and involution or atrophy. Both go on concurrently throughout life but atrophy predominates in old age. Involution may not start at one and the same age, in all the organs and in all the people. Senescence or senility is physiological, but it becomes morbid if involution is irregular and starts early. Biological age may thus differ in persons of same chronological age.

The number of aged people is gradually increasing due to general improvement in health. The expectation of life at birth in India currently is 63.2 years for males and 66.4 years for females⁵ compared to only 23.8 years (combined) in 1901. The life expectancy in India at 60 years age is 14.6 years in men and 17.0 years in women.⁶ In 2002, there was an estimated 605 million old persons in the world, of which 400 million were living in low income countries. Italy and Japan had highest proportions of older persons (about 16.7% and 16% respectively) in the year 2003.⁷ In India, 2001 census revealed that 77 million (7.5% of Indian population) people were aged 60 years and above with 1028 males/

1000 females with projected figure of 301 million (17.3%) elderly and 1007 males/1000 females by 2051.⁸

People in industrialized countries are living longer than ever before. In this century alone, average life expectancy at birth has increased more than 25 years and nearly 5 of those 25 years have been added to average life expectancy from a base age of 65 years.⁹ Indeed, the most rapidly growing age group in the world comprises those aged 80+. The situation in Japan is unique in the world in this regard. Japan’s elderly population has doubled just in 25 years, while the same process occurred over 150 years in some Western countries. In 1975, the proportion of Japan’s population aged 65 and above was 8 percent. This proportion had increased to 10 percent by 1985 and is expected to reach 23.6 percent in 2021.

The problems of the old are worsened by a large number of people migrating from villages to larger towns and cities. It is usually the younger people who move away from their native villages in search of jobs and the elderly are left behind to cope as best as they can with poverty and failing health, with nobody to care for them.

It would be interesting to know the outcome of perfect geriatric services as regards increase in lifespan. It has been calculated that with reference to the current status of longevity in the developed countries, further gains in life expectancy would be modest. For example, elimination of all forms of cancer will add just three years to life expectancy of men. Elimination of all forms of ischemic heart disease would add another 3.5 years. Eliminating cancer, heart disease and diabetes together will increase life expectancy at birth by only 15.27 years.¹⁰

The Problems of the Old

Aging has become an important issue because of the dramatic changes in life expectancy. People over 60 currently constitute a fifth of the British population but will be a third by 2030.¹¹ In 1951, Britain had 300 people aged over 100 years—By 2031, it will have 34,000.⁹ Other developed countries have seen the same pattern while the recently emerging economies are witnessing a much more rapid transition in their age structure. Today 60 percent of those aged 60+ live in

the developing countries. Their proportion will increase to 80 percent by 2050.¹¹ With population aging come health problems and disabilities that impact on the quality of life of the elderly. However, much can be done to relieve the hardships of old age. In order to do so, we must understand the problems of the elderly people. These are of four types: economic, social, mental and physical.

Economic Problems

On retirement, the income is suddenly reduced. The bank balance and provident fund are spent up in making a house or in the marriages of grown up children. It becomes difficult to manage, the household affairs or to purchase amenities or comforts, which are needed all the more in old age. Economic hardships, with continued low standard of living, affect the body and the mind. The solution lies in planning ahead for age. In order to avoid poverty in old age, the state should provide social security in the form of welfare services, including free nursing and medical care, subsidised housing and old age pension, etc.

Social Problems

Old age is mainly a social problem. A person, retired from active job, loses status. He might have lost his spouse, other near and dear ones and good friends. The sons, daughters and young friends get busy in their own affairs. There is a painful feeling of futility and genuine loneliness, which becomes all the more acute because of the increasing number of small nuclear families nowadays. The old person wants to be useful to society, to mix up with friends and relatives and to play with children. He also needs security and love. These needs were, to a large extent, fulfilled in large joint families earlier. The solution lies in inculcating a feeling in the elderly that they are wanted and needed by others and are useful to society. The following suggestions are useful in this direction:

- An elderly person should keep himself “*too busy to be ill and too healthy to be old*”. According to an old saying, the panacea for old age is “*Satat Udyog, Shant Man*” (Be busy, be calm). Raising the age of retirement would help people to be active and busy in their later years. The retirement age is 58 to 60 in India in comparison to 65 in UK and USA. Formerly, large joint families used to provide opportunities to most old people to remain busy in some suitable tasks according to their capabilities. These opportunities are declining now with the gradual breakdown of the joint family system.
- They should know how to utilize leisure time when the active working phase of life comes to an end. Reading, writing, and club visits, etc. are good pastimes.

- Old persons should absorb themselves in social service. They can inspire people to come to them because they are experienced, learned, helpful and useful. They win the affection of family, friends and the community in general. Such people grow old and pass their time gracefully till the end. Our cultural and social pattern of life is different from the West. Ties between the old and the young are strong and the old are respected as they share the family goals. True happiness depends ultimately on being able to identify oneself, until, death with the continuing stream of life.

Depression is a common problem of old age. It may be precipitated by psychosocial factors like retirement, economic deprivation, bereavement and adverse family circumstances. Besides, drug induced depression from antihypertensive drugs, steroids and tranquilisers is also common. Organic depression may also occur after a stroke, heart attack or other serious physical disability.

- Religious pursuits may provide a satisfying avenue to old persons.

An aging man should plan ahead a satisfying avenue to old persons. An aging man should plan ahead to adapt him, self to adjust to the new environments. His personality and self-respect should be preserved.

Mental Problems

Mental changes are an inevitable accompaniment of old age. A certain degree of cerebral atrophy is universal in the elderly and is associated with loss of memory and slowing of reflexes. Sexual changes, such as menopause in women and decrease of sexual activity in men, aggravate mental tension. As a result, some elderly persons may become irritable and high strung.

Senile dementia is a well-known entity. However, there is evidence that it is more common in USA than in China and Japan.¹² A quarter of all suicides in UK occur in the elderly¹³ and the majority of these occur in those with mental illness, usually depression, associated with social isolation.¹⁴

Apart from appropriate psychiatric management when indicated, mental problems of the elderly can be mitigated to a large extent through sympathetic understanding and sincere affection rather than through pity. Loneliness has to be decreased by suitable job, hobbies, social service and club life, etc. As far as possible, an elderly person should live with or near his blood relations and not be removed to old age homes. His dignity and self-respect have to be preserved. The motto should be, ‘add life to years and not merely years to life’.

It should be remembered that sleep is important for mental health. Contrary to general belief, the need for sleep is not reduced with age.

Physical Problems

There are recognizable physical changes as people age. These are well-defined by the time they reach their 80's. Loss of elasticity of the skin, thinning and loss of hair, brittleness of bones and weakness of muscles, slowness of movements, unsteadiness of gait, and sluggishness of reflexes are characteristic manifestations of aging. Organ functions deteriorate and there is often impairment of the special senses, especially hearing and sight. The heat-regulating mechanism of the body can deteriorate, adding to the risk of hypothermia. Hypertension and coronary disease are more common in old age. Obesity is more common in the elderly. Osteoporosis and osteoarthritis commonly occur in old age. The former is associated with fractures due to relatively minor falls at home. Prostate enlargement, diabetes and cancer are other diseases common in old age.

Excess heat can be particularly hard upon elderly patients with cardiac and respiratory problems. Such persons constituted the bulk of 900 individuals who died in Greece in the summer of 1987, when temperature rose to 43°C.

Heart attacks can be precipitated as a result of heat stress in elderly patients with coronary disease when ambient temperature rises too much in summer. This can happen especially when electricity fails in cities for a few hours.¹⁵

Accidents, often at home, are an important cause of physical illness in the elderly. Falls are the leading cause of death among people aged 75+ and are also responsible for appreciable morbidity including fracture, impaired mobility, fear of falling and admission to long-term care facilities.¹⁶ Three lakh people aged 65 years and above attend the accident and emergency department of hospitals in England and Wales annually.¹⁵ Most of these occur at home. The incidence increases with age, being 6 percent at 65 to 74 years and 11 percent in 75+ age group.¹⁷

Some physiological functions, such as the immune system in the human body, decline when one gets old and it becomes difficult for an aged person to stave off illness. The metabolism also begins to slow as age advances. The muscles gradually shrink and there is a tendency to become fatter. Kidneys are said to lose up to 50 percent of their efficiency between age of 30 and 80. Lungs lose, on the average, 30 to 50 percent of their maximum breathing capacity between ages 30 and 80. Blood vessels lose their elasticity. Bone mass drops. Aged women are particularly prone to develop osteoporosis, with the bones becoming dangerously thin and fragile. In old age, senses also flag. Taste and the sense of smell decline. The two together can also lead to lack of appetite. Hearing fades and vision deteriorates. The pupil shrinks, reducing the amount of light reaching the retina. The lens becomes hard and clouded. Most persons above sixty years of age develop cataract.

Nutritional Status

Poor nutritional status is highly prevalent in the elderly and is correlated with decreased functionality, and increased morbidity and mortality. Therefore, nutrition screening and evaluation is important in all elderly people. Body mass index (BMI) is a good indicator of mortality risk, but gives no information on body composition.

Assessment of Malnutrition in the Elderly

Assessment of nutritional status in the elderly starts with screening followed by proper assessment. The easiest method for assessing nutritional status is the change in weight over time.

When comparing prevalence data, it is crucial to determine what cut-points of BMI were used for malnutrition, since cut-points vary among different assessment tools: NRS 2002, BMI <20.5; MUST, BMI <20; and MNA, BMI <23.

Assessment Tools¹⁸

There are six commonly used nutritional assessment tools:

1. **Subjective Global Assessment (SGA)**
2. **Malnutrition Universal Screening Tool (MUST):** The MUST test uses BMI <20 as its cut-point.
3. **Simplified Nutritional Appetite Questionnaire (SNAQ):** The SNAQ is easy to use and predicts weight loss based on appetite. SNAQ score d"14 indicates significant risk of at least 5 percent weight loss within the next 6 months.¹⁹
4. **Nutritional Risk Screening 2002 (NRS 2002):** The NRS 2002 is designed for the acute-care setting, to identify patients in a hospital setting who are malnourished or at risk for malnourishment and who would benefit from improvement of their nutritional status.²⁰
5. **Mini Nutritional Assessment (MNA):** The MNA is the only nutritional assessment tool specifically developed for the elderly. This is reflected in the threshold for BMI for underweight (20 kg/m²), which is higher for the elderly than for younger people (18.5 kg/m²). The MNA has two parts—a short form and a full form. It comprises 18 questions dealing with overall assessment of health, nutrition, anthropometry and subjective self-estimation. The total score for the full MNA is 30 points. Based on the score, an individual will be assigned to one of three categories: well nourished (>23); at risk for malnutrition (17–23.5); and malnourished (<17). The MNA is very useful in demonstrating a direct correlation between nutritional status and survival (frailty).²¹
6. **MNA-short form (MNA-SF):** This consists of six questions and can be completed in 2 to 3 minutes.

In addition to appetite and weight loss, it incorporates other domains, such as functionality (mobility), depression and dementia, which are crucial for the elderly. The new revised MNA-SF allows calf circumference to be used as an alternative when BMI is not available.²²

Malnutrition in the elderly results from reduced food intake as a result of age-related physiological changes, such as a curbed appetite, early satiation, constipation, constricted senses (vision, smell and taste) and dementia. Changes in body composition or decrease in lean body mass results in reduced basal metabolic rate, which in turn reduces energy requirement. Although energy requirements decline with age, but the nutrient requirements remain the same, hence the need for nutrient-dense foods. A combination of moderate exercise and oral nutrient supplements has been shown to be more effective than single interventions.

A physician has to give total care to the old man in whom both social and medical problem coexist. In the field of geriatrics, one finds ample scope for practice of social as well as clinical medicine. Elderly men often have multiple pathologies. It would be difficult to find many elderly persons who do not have some acute or chronic illness. Hence it has been suggested by an international study group²³ that "Health in the elderly is best measured in terms of function. The degree of fitness rather than the extent of pathology may be used as a measure of the amount of services the aged will require from the community."

Katz *et al*²⁴ developed an index of ADL (Activities of Daily Living) based on appraisal of level of independence in six activities: dressing, bathing, going to the toilet, continence of urine and feces, transferring (i.e. movement in and out of bed or chair) and feeding. The fundamental nature of these activities of daily living has been emphasized by the observation that the order in which the components of the index of ADL are lost in elderly people is the same in which they are acquired during childhood. Such an assessment of ADL is widely applicable and is easily understood and communicated by the staff in different settings.

In the USA, 42.5 percent persons aged 65 and above were found to have no disability, i.e. they were independently able to do all of the following activities: bathing, personal grooming, dressing, eating, transferring from bed to chair, using the toilet, walking across a small room, walking half a mile, climbing one flight of stairs, doing heavy house work, pushing and pulling large objects like living room chairs, stooping, crouching or kneeling, lifting and carrying weights over 10 pounds, reaching or extending arms above shoulder level and writing or handling small objects.¹⁷ However, two-thirds of these persons without disability had history of chronic diseases like heart attack, stroke, cancer, diabetes, arthritis, hypertension, etc. Only 15.3 percent of persons aged 65

and above had neither disability nor chronic disease.¹⁰

Very few surveys in geriatric population have been carried out in India.^{25,26} According to a survey in rural population of Delhi, 74.5 percent persons aged 60 and above had visual impairment while 24 percent had impairment of hearing.¹⁸

Physical activity retards the process of deterioration that one associates with age and brings about a number of benefits. Some of these benefits are a lower risk of coronary heart disease, maintenance of balance and flexibility, better mobility, ability to carry out the rituals of daily living with less fatigue and more self-confidence, enhanced independence and an improved mental state.

Administrative Aspects

Promotive, preventive, curative as well as rehabilitative measures have to be taken for the geriatric problems discussed above. In England, the old are the heaviest users of the health service and consumption increases with age. They account for nearly half the patients in hospital as well as general practice.¹¹ In most developed countries the elderly constitute about 12 percent of the population, but they consume 25 to 30 percent of the health service expenditure on drugs.²⁷ In India also, we must prepare for adequate health care to the elderly in view of the gradually increasing life span. Since our hospitals have no departments of geriatrics, the elder citizens have to depend on the usual hospital OPDs, where they have to wait for hours before their turn comes. And this, after a bus journey at an age when they cannot easily hop in and out of a street bus in which the conductor and driver do not bother to make things easy for the aged. In the hospital, too, they are dismissed soon by the doctors, with nobody to listen to their tales of real and imaginary grievances at an age when they feel lonely and wish to pour their heart out to someone patient and sympathetic enough to listen to them.

Enough attention is not paid to old people in India by the State and voluntary organizations. Old people's homes are a necessity in all big towns. Age Care India, a voluntary organization, has already provided such facilities in some cities. Ideally, there should be geriatric social workers, health visitors, nurses, and geriatric units and hospitals. Special hospitals are needed for the incontinent, mental and badly incapacitated old patients.

Geriatrics should be recognised as more than a mere branch of general medicine so that geriatricians-specialists in problems and diseases of old age, are available in required numbers. It is recommended: that the following steps should be taken: (i) A geriatric hospital exclusively for elderly people should be established in every state in India to cater to the specific needs of the elderly; (ii) Separate geriatric OPDs be established at all the hospitals to avoid standing in long queues for which the elderly are physically not capable because of their manifold handicaps;

(iii) Medical treatment of all old age pensioners, service pensioners and elderly people of 65 years and above should be free at all the hospitals; (iv) Day care camps for the old; (v) Proper civic amenities for the old, such as separate entry and seats in trains and buses, privileged places in bank queues, and substantial travel concessions.²⁸

Evidence shows that a substantial proportion of chronic diseases associated with aging can be prevented or at least postponed. Intervention trials have shown that reduction of blood pressure by 6 mm reduces the risk of stroke by 40 percent and the heart attack by 15 percent, while a 10 percent reduction in blood cholesterol will reduce risk of coronary heart disease by 30 percent.^{29,30} These interventions can have a substantial impact on the health of the aged. Dietary changes also have a significant impact on the health of the elderly. Low bone mass increases the risk of fracture but this risk can be decreased by 30 to 50 percent by ensuring that older people are provided vitamin D and calcium or biphosphonates.^{31,32} Prevention of cognitive loss or dementia can also be prevented by aspirin and dietary patterns as these also seem to share a similar pathway like atherosclerosis.³³ Thus general public health measures may have additional benefits for age-related chronic disease.

The aging and health program was launched by WHO in 1995. It has the following components: life course, promoting health and well-being, culture, gender, intergenerational relationships and ethics. This program has helped to create a much broader approach to health promotion, with a strong community focus rather than an individual focus.³⁴

According to Sir Humphry Rolleston, “a healthy old age and physiological (or natural) death without attendant disabilities and horrors should be the common lot of man, instead of being somewhat exceptional in the case of the first and extremely rare as regards the final act”.³⁵

Neglect of parents has become a big issue, so much so that the Indian government had to pass ‘**The Maintenance and Welfare of Parents and Senior Citizens Bill 2006**’—which makes it imperative for adult children to look after their parents.³⁶

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Mental Health is one of the three important aspects of health (others being physical and social) incorporated in the WHO definition of health. Just as physical health is subject to a lot of variations and fluctuations, so also is mental health. Mental health is generally equated with happiness, satisfaction and normal behavior. It shows in one's ways of thinking, adjustment in life, relationship with others and effective functioning in the different roles of daily life.¹ Mental health means a harmonious working of the mind, which results in a well adjusted personality that can:

- Adjust to one's environment pleasantly without being disturbed.
- Fully utilize one's talents in creative work and help others to do the same.
- Realize one's own limitations and also those of others
- Be realistic in outlook, confident of one's own capacity and able to find meaning in life.
- Enjoy one's work and marital and other social relationships, and
- Provide love and affection.

Mental ill-health is one of the most disturbing and disabling conditions of life. It affects not only the person concerned but also his family and the community and is made worse by the social stigma attached to it. A large number of persons are affected, many of whom are children. As many as 20 percent of all patients attending general health care facilities in both developed and developing countries do so because of psychological symptoms. The problem is gradually on the increase due to such factors as urbanization, industrialization and increase in lifespan, together with breakup of the joint family system, which has increased the psychiatric problems of the elderly. To this is added the problem of population explosion which has led the problem of population explosion which has led to an increase in poverty, disease, crime, unemployment, etc. all of which are stressful situations precipitating mental illness. It is also one of the few problems that impose a very heavy burden on the family.¹

Prevalence of Mental Illness

The prevalence of mental illness shows wide variation in various surveys. This is partly because of the fact that

there is no universally accepted definition of what constitutes mental illness. Surveys in different parts of the country have revealed a prevalence of 1.8 percent to 10.2 percent in rural areas and 2.5 percent to 14 percent in urban areas.² The prevalence of psychiatric illness is almost same in India and the West, about 8 to 10 per 1000 population. During the whole life time, about 25 percent persons suffer from psychological stress or illness some time in their life. Also, one-fourth of patients seen by medical practitioners have a psychological basis. It is obvious that the prevalence of mental illness is fairly high in both urban, and rural areas. In spite of the wide difference in findings of the different surveys, the prevalence rates of schizophrenia and organic psychoses are constant at about 2 per 1000 and 1 per 1000 population respectively. A representative analysis of admission to the psychiatry department of a general hospital shows the following pattern.²

Schizophrenia	58.3%
Affective disorders	9.8%
Other psychoses	2.3%
Neuroses	12.2%
Organic brain syndrome	5.2%
Mental retardation	3.8%
Miscellaneous	8.5%

For comparison, the US figures for hospitalization for mental illness are presented below.³

Schizophrenia	45.6%
Manic-depressive psychosis	7.6%
Psychosis with mental deficiency	6.0%
Alcoholic psychosis	3.0%
Involitional psychosis	3.0%
Senile psychosis	12.2%
Personality disorders (nonalcoholic)	4.0%
Psychoneuroses	6.0%
Miscellaneous	12.6%

Mental ill-health is a worldwide problem. The majority of cases (80%) are to be found in the developing countries. Children below 15 years constitute one-third of the global cases. Worldwide, there are about 40 million cases of severe mental illness, 20 million cases of epilepsy and 200 million cases incapacitated by other minor mental and neurological conditions. In India, mental illness contributes to 30 percent of all causes of disability. Roughly 1 to 2 percent (7-14 million) of the population

is affected, of which 30 percent are children, the majority of cases being those of mental retardation. The numbers affected per thousand population are as follows:¹

Serious mental disorder	10-20 per thousand
Minor mental disorder	20-60 per thousand
Emotional problems	200 per thousand

In India about 2.5 lakh new cases are added per year.^{1,4}

Special attention needs to be given to mental ill health in children. It is estimated that 0.5 to 1 percent of all children are mentally retarded while 1 to 2 percent have behavioral disorders. Alcoholism and drug abuse are other problems which are on the increase.

There is some indication that the prevalence of mental illness is gradually increasing. According to US data,³ the period prevalence* of admission for mental illness per 10,000 population was 1032 in 1955 and 2997 in 1975. It is estimated that at any one time, about 10 percent US population is in need of treatment for some mental or emotional disorder.⁵

Etiology

The etiology of mental ill-health is very complex and not well understood. A very large group of mental disorders is still called 'functional' because no pathological, biochemical or hormonal changes are discovered with the present investigative techniques. With advancing scientific methods, it is likely that such disorders will come more and more under the organic category and, consequently, within the domain of more precise and scientific treatment, prevention and earlier detection. Various etiological factors are discussed below:

CONSTITUTIONAL FACTORS

The constitution is based on heredity and is modified by various types of environment. For example, a child born to schizophrenic parents has 40 times higher risk of having schizophrenia than a child born to normal parents.

PHYSICAL FACTORS

Infections, toxins, tumors, trauma, vascular injury, nutritional deficiency, metabolic defects and degenerative and autoimmune processes may cause various types of organic mental disease.

PSYCHOLOGICAL FACTORS

Conflicts between ego and id, or between these two and superego, frequently occur in life and produce painful

emotional states of nervous or mental tension**. This tension may get modified or eased off by unconscious defence mechanisms of ego. Failing that, it produces secondary effects on mind, damaging physical health, intellect, efficiency, emotional balance and harmony with others.

ENVIRONMENTAL FACTORS

Singh⁶ has identified *three types of environmental factors responsible for mental disorder* in a study of 77 indoor patients in a psychiatry ward. These factors are social, economic and sexual. *Social factors* precipitating mental illness included:

- Death of son
- Torture and severe beating
- Drug addiction in company
- Religious fantasy
- No child or only female children
- Discrimination in appointment or promotion
- Lack of cooperation in crises by the near and dear ones
- Failure in examination.

Common *economic factors* were extreme poverty and loss in business. *Sexual factors* related to mental disorders were sexual starvation due to separation of the spouse, adultery by spouse and sexual assault.

Types of Mental Disorders

Mental health problems can be of various types. On the one hand are the psychiatric disorders classified as psychosis and neurosis. Then there are the disorders peculiar to particular age groups, such as mental retardation, behavior problems and juvenile delinquency in childhood and degenerative psychosis or senile dementia in old age. In addition, there is a heterogenous group of psychosomatic diseases comprising organic illnesses in whose etiology psychological factors play a role.

Mental Deficiency or Retardation

Prevalence of mental deficiency is estimated to be 1 to 3 percent in the world. It may be due to genetic, infective (pre and postnatal), nutritional, and hormonal causes or due to brain injury. The various grades of deficiency are:

- *Mild*: Intelligence quotient (IQ) varies between 50 and 70 and the mental age is 8 to 11 years. If care is taken early, the children can become self-supporting citizens. They are educable as well as trainable. 3/4th of the total retarded fall in this category.⁷

***Id* is the "biological mind" common to all organisms. It is related to the sense of physical and emotional security and the urge for procreation. *Ego* is the intellectual understanding of the self and the environment. Egoistic drives (ambitions, ideals and standards) are formed within the ego. The *superego* or conscience enshrines the do's and don'ts of society learnt through, and reinforced by, social, normal and religious forces.

*Period prevalence means number of cases at the beginning of the year plus new cases during the year.

- *Moderate:* Intelligence quotient varies between 25 and 50 and mental age is 4 to 7 years. They can attain partial independence if properly trained. They are not educable but are trainable.
- *Severe:* Intelligence quotient is below 25 and their mental age is about 3 years. They remain completely dependent and need to be looked after continuously.

In addition, there are children whose IQ may vary from 75 to 90. They are classified as *mentally subnormal*. They are unable to keep up with their age group at school. Such children are educable but remain 2 to 3 years behind their normal counterparts. It is better to have special schools for such children. Otherwise, a considerable amount of inferiority complex may result among them.

Mentally deficient children may have, in addition, epilepsy, delinquency and some other psychiatric disorder.

Behavior Disorders Among Children

These are manifested as bed-wetting, tantrums, stealing, lying, aggressiveness, playing truant from school, etc. These are usually the result of a poor family and social environment at home or school, resulting in a sense of rejection and hunger for love. Child guidance clinics and social welfare agencies can play an important role in the investigation and management of such disorders.

Juvenile Delinquency

Juvenile delinquency is defined as antisocial behavior on the part of boys and girls, under 18 years of age, that is not accepted by the society and calls for some kind of admonishment, punishment or corrective measures. The causes of juvenile delinquency are many—mental deficiency, organic brain disease, manifest psychiatric disorder, adverse home and social conditions, poor family relations and “parental rejection”, etc.

Mental Disease

There are five groups of mental disorders—acute brain disorders, chronic brain disorders, neuroses, psychoses and personality disorders.

1. *Acute brain disorders:* They result from temporary, reversible, diffuse impairment of brain tissue function, e.g. acute alcoholic intoxication or acute delirium.
2. *Chronic brain disorders:* They result from relatively permanent, more or less irreversible and diffuse impairment of cerebral tissue function, e.g. senile dementia, cerebral syphilis, etc.
3. *Psychotic disorders:* They are characterized by a varying degree of personality disintegration and failure to correctly evaluate external reality. The group includes involuntional depression, manic depressive syndrome and schizophrenia.

4. *Neurotic disorders:* These are also called psychoneuroses. These are characterized by anxiety which may be overt or subconscious. Such cases do not present gross disorganization of personality, nor do they exhibit gross distortion of external reality. Hysteria falls in this category.

A baffling condition of mass hysteria is sometimes known to occur. For example, 900 school girls in Egypt suffered from a strange fainting epidemic in April 1993. Extensive investigations found it to be a case of mass hysteria as a result of pent-up pressures of three types: (i) Fundamentalist pressures from the clergy, whose efforts almost make the very fact of womanhood a matter of shame, something to be covered behind a veil; (ii) Economic pressures forcing women to come out in the open to work and compete with males; (iii) Psychosocial pressures commonly associated with adolescence.

5. *Personality disorders:* They are characterized by developmental defects or pathological trends in the personality structure with little or no sense of distress and minimal subjective anxiety.

Psychosomatic Disorders

These are diseases with bodily manifestations in whose etiology psychological factors are believed to play some part. These include the following:

- Allergic disorders, such as asthma, eczema and urticaria
- Thyrotoxicosis
- Hypertension
- Coronary artery disease
- Duodenal ulcer
- Rheumatoid arthritis.

Drug Addiction

Drug addiction has markedly increased during past three decades all over the world, including India, and has assumed epidemic proportions according to the WHO. The highest incidence of the epidemic is found in the slum areas. An idea of its prevalence can be had from the fact that at an annual global turnover of more than 800 billion dollars, the narcotics industry is second only to defence industry. According to a recent estimate, it may well become the largest organized industry in the world if the present rate of growth continues. Over 50 million people in the world are addicted to hard drugs and narcotics. The number in India is 3 to 5 million, 2 lakh of which are in Delhi alone. In India, there are one million heroin addicts, two million opium addicts and several million cannabis addicts. It may be mentioned that the ratio of drug abusers to alcoholics having serious alcohol abuse problems is 1:30.

Definitions

A drug is any substance (other than food) that produces changes in the physical or mental functioning of an individual.

Drug use is taking a drug for medical purposes like treating an illness, protecting the body against a disease or to relieve pain or tension.

Drug abuse is taking a drug for other than medical reasons in amount, strength, frequency and manner that damages the physical and mental functions.

Addiction is the result of drug abuse, which produces both dependence and drug tolerance.

Dependence

Physical dependence: It occurs when a drug user's body becomes so accustomed to a particular drug that he requires the drug in order to function normally. When a person who is physically dependent on a drug abruptly stops taking it, he experiences a variety of adverse effects which are collectively known as *withdrawal symptoms*. These withdrawal symptoms are specific to the type of the drug abused.

Psychological dependence: It occurs when a drug is so central to a person's thoughts, emotions and activities that it is extremely difficult to stop using it, or even stop thinking about it. Psychological dependence is marked by an intense craving and an abnormal obsession for the drug and its effects.

Tolerance: Tolerance to a drug means requiring *more and more of a drug to get the same effects*. Tolerance increases the physical health hazards of any drug, simply because the amount taken increases over time.

Addiction as a Disease

In the year 1956, addiction was declared a disease by the American Medical Association. It is a disease which can be treated and arrested. The characteristic features of the disease are:

IT IS A PRIMARY DISEASE

Addiction as such is a disease and not a symptom of a psychological disorder. It can cause mental, emotional and physical problems. These associated problems cannot be treated effectively unless addiction is treated first.

IT IS A PROGRESSIVE DISEASE

The disease progresses from bad to worse. Sometimes, there may be intermittent periods of improvement. However, the disease invariably follows a course of serious deterioration over a period of time.

THE DISEASE IS TERMINAL

An addict may die due to any complication, but the factor which induces the complication itself is the abuse of drug which is also the real agent behind the death.

IT IS A PERMANENT DISEASE

The disease cannot be cured but can be successfully arrested by totally abstaining from the drug. Even if an addict has remained sober (drug-free) for many years, he should not take even small doses of the drug. This will lead him to obsessive drug-taking. Hence addiction is considered to be a permanent disease.

Types of Drug Abuse

Any drug can be abused intentionally in the following ways:

- **Too much:** Taking too much of any drug at one time or taking small doses too frequently can cause problems ranging from fatal overdose to addiction. For example, taking an overdose of sleeping pills can result in death.
- **Too long:** A drug can be abused if it is taken regularly for a long period of time. Some medicines, such as pain killers (e.g. pethidine), can cause serious problems if they are taken after they are no longer needed.
- **Wrong use:** A drug can be abused if it is taken for the wrong reasons or taken without following proper instructions. For example, taking phenobarbitone, an antiepileptic drug, for reasons other than the prescribed reason.
- **Wrong combination:** A drug can be abused if it is taken in combination with certain other drugs knowingly or unknowingly. Some combinations can prove to be fatal. For example, barbiturates with alcohol can cause death.
- **Wrong drug:** With some drugs like brown sugar, the potential damages are extremely high and there are no legitimate uses. These drugs can cause serious problems, no matter how or when they are taken. With such drugs, there is no difference between use and abuse. To use them is to abuse them.

Reasons for Using Drugs

A person may have more than one reason to start using drugs. People may start using drugs for one reason (curiosity, pleasure, social pressure or medical reason) and may continue using it for quite another (such as psychological dependence or group pressure).

- **Curiosity:** Young people are especially tempted to experiment with drugs.
- **Emotional pressure:** Some people use psychoactive drugs (those which affect the mind or behavior) to relieve various emotional problems such as anxiety,

nervousness or depression. Others use drugs simply because they are bored. Insecure people may take drugs to boost their self-confidence. Some young people may use drugs as an expression of alienation or rebellion.

- **Social pressures:** The social pressures for using drugs can be very strong. Young people may be influenced by popular songs glorifying the effects of drugs or by famous singers, musicians or athletes who are known to use drugs. Children are specially influenced by their parents whose casual use of alcohol, nicotine (cigarettes) and other drugs may make drug-taking seem normal or safe or even justifiable.
- **Group pressures:** In some groups, drug-taking is the fashionable thing to do. It is the badge of belonging and the key to social acceptance. Abstainers are excluded.
- **Availability:** Drugs, both legal and illegal, are now more easily available. More people than ever before are directly or indirectly exposed to them.
- **Previous drug use:** For most people, trying a drug for the first time is a major step. A single experiment does not mean a person will become a regular drug user, but it may remove some of the barriers against trying drugs again. It is also true that people who are regular users of one drug are more likely to use other drugs as well.
- **Dependence:** Some people use drugs because they have become physically or psychologically dependent on them. It does not matter whether the drug is legal or illegal, mild or strong or whether it was first used for medical or nonmedical purposes. When people continue using a certain drug because they do not feel right without it, they can be said to be drug dependent.

How to Identify Drug Abusers?

Some probable signs are:

- Academic changes
 - Poor attendance at school or college
 - Decline in academic performance
- Physical changes
 - Slurring of speech
 - Sweating at night
 - Loss of appetite
 - Reddening of eyes
 - Unsteady gait
 - Fresh injection sites
 - Temper tantrums
 - Puffiness under eyes
- Withdrawal symptoms
- Other changes
 - Blood stains on clothes
 - Disappearance of articles from home. Addicts often sell articles to obtain money for the purchase of drugs

- Odor on breath and clothing
- Presence of needles, syringes, strange packets, etc. at home
- Preference of solitude, especially spending long hours in the toilet.

The control of drug addiction essentially involves a two-pronged strategy—diminishing the supply of narcotics and diminishing the demand for them. The former is essentially to be tackled by the government, using various strategies such as stricter enforcement of the Narcotic Drugs and Psychotropic Substances Act. The latter strategy is primarily the responsibility of voluntary organizations.

Mental Health Care

There have been three major revolutions in the mental health care in the world, the first was brought about by Phillipe Pinel in 1775 when he introduced a humane approach to the mentally ill, who were earlier kept chained and were treated like animals. The second followed the work of Sigmund Freud and his psychoanalysis. The third, that of community psychiatry, is largely a synthesis of the first two.⁸ The third phase has just begun in India. The earlier policy of establishing mental hospitals or asylums is now no longer followed. Out of the 42 such hospitals in India, the last one at Shahdara, Delhi, was established in 1966. The present trend is to have psychiatry beds as part of a general hospital under the care of departments of psychiatry.⁸

Prevention and Control of Mental Illness

Primary Prevention

This relates to prevention before mental disorder actually occurs. Mental stress is probably the commonest cause of mental ill health. Three fundamental psychological needs of an individual are love, security from want and understanding of his difficulties by others. Stress results when these wants are not fulfilled. The measures conducive to good mental health are described below.

- **Personality development:** For development of a strong and well adjusted personality, a proper, pleasant, affectionate but disciplined environment is necessary, both at home and school and in the society. Parents, teachers, religious leaders, priests and social workers play an important role in producing such an environment and helping in formation of good personality. Scouting, NCC and other such activities foster team spirit in the young and inculcate the quality of conforming to discipline and adjusting to adverse situations.
- **Youth welfare:** Counseling, information and employment services for the youth, who are at the

threshold of adult responsibilities, will save frustration and disappointment. Youth guidance clinics are necessary for adolescents.

- *Social welfare:* Amelioration of adverse social conditions of poverty, ignorance and illiteracy will considerably help in improving mental health. Provision of proper education and job opportunities will reduce mental tensions and frustrations.
- *Family life:* A major source of mental tension nowadays is the decline in joint family system and disruption of smooth family life because of the dual demands of family and career upon working women. Efforts aimed at preservation of joint family and at provision of support and amenities to women will go a long way towards promotion of mental health.

Secondary Prevention

This pertains to early diagnosis and treatment. The necessary steps include the following:

- *Enhancing the capability of doctors:* There are only 1500 psychiatrists in the country at present. This number is not sufficient to take care of the large number of the mentally ill. Hence it is necessary to include sufficient teaching and training in psychiatry in the MBBS curriculum, so that general doctors and medical practitioners may be capable of handling routine mental illness independently.
- *Child guidance clinics:* Early detection of behavior problems and their rectification can be done at Child Guidance Clinics which should be established in adequate numbers, at least one at each district headquarter. The staff should include a psychiatrist, psychologist and psychiatric social worker.
- *Public education and cooperation:* Health education by PHC staff and school teachers to the public regarding early recognition and treatment of mentally ill patients and information about the availability of various types of mental health services in the community will be very helpful in early diagnosis and treatment of mental disorders.

Tertiary Prevention

Its aim is to reduce the duration of mental illness, to minimize disability and to rehabilitate the patient as a useful member of society. The measures include:⁹

- *Day care programs:* These cater to the needs of patients who have undergone hospital treatment and who live within the city limits. Here the patients spend their time in a structured way, depending on their clinical condition, psychosocial functioning and other related factors. This service helps the patients to maintain their improved condition and to relearn the social skills for community living.
- *Half way homes:* These stimulate family living and serve as short stay homes between the hospital and

the patient's family. Patients who require support or guidance, rather than active medical or nursing care, are admitted here for brief periods ranging from a few weeks to six months.

- *Self help groups:* These are groups of parents having mentally retarded children. Such parents need specific channels and facilities by which they can share and resolve their problems with their counterparts. *Self help groups*, with the minimal participation of professionals and continuous and consistent interaction between parents, are a step in this direction. Such self help groups invariably lead to the formation of welfare associations, special schools and training centers for the mentally retarded.
- *Family service programs:* These offer professional counseling services. Besides helping to sort out problems within the family, counseling helps promote effective household management and work adjustment, and provides vocational training, planning for the care of the handicapped, the chronically ill, and the aged.
- *Industrial therapy centers:* Here the patients are grouped according to their abilities and skills and are given specific work assignments in various occupational units. Depending on the work output, they are paid monthly incentives. Work experience in this setting prepares them for open employment in the community. Such a center has been functioning in Madras in one of the oldest mental hospitals in India.⁹
- *Vocational training centers:* A few centers are at present giving vocational training to both the physically handicapped and the mentally disabled under one roof. While the efficiency and replicability of this approach is being studied, it is likely to emerge as a cost-effective method of rehabilitation for the handicapped persons in general.⁹
- *Home care:* It offers better scope for tapping the rehabilitation potential of the family. In addition, it proves less costly and more effective than hospital treatment. From the rehabilitation point of view, home care programs can be considered fertile soil for innovative and indigenous helping processes.

National Mental Health Program

The Government of India launched the National Mental Health Program in 1985 during the seventh five-year plan.^{4,10}

Objectives

- To ensure availability and accessibility of minimum mental health care for all in the foreseeable future, particularly for the most vulnerable and underprivileged sections of the population.

- To encourage application of mental health knowledge in general health care and in social development.
- To promote community participation in the mental health service development and to stimulate efforts towards self help in the community.

Personnel Involved in the Program

The health guides at village level will participate in case identification and referral of patients and will help to supervise the follow-up of patients in need of long-term maintenance therapy.

The health workers at subcenters level would provide first aid care and follow-up services.

The health assistants are entrusted the task of early recognition and management of priority psychiatric conditions, carried out under the supervision of the medical officer.

The PHC medical officer is vested with the overall responsibility of organizing and supervising the primary level mental health care for the population under PHC jurisdiction.

Services

The service component includes three activities: Treatment, Rehabilitation and Prevention.

TREATMENT

The focus is on the following morbidity conditions:

- Acute psychoses of schizophrenia, affective or unknown etiology, paranoid reactions and psychosis resulting from cerebral involvement (e.g. malarial, alcoholic and epileptic psychosis)
- Chronic or frequently recurring mental illness, such as some cases of schizophrenia, cyclic affective psychosis, epileptic psychosis, dementia and encephalopathies associated with intoxication and chronic organic diseases
- Emotional illness like anxiety, hysteria and neurotic depression.

Specific forms of treatment to be administered by various levels of auxiliaries and doctors are set out for this purpose.

REHABILITATION

Maintenance treatment of epileptics and psychotics at community level is an important rehabilitative activity. Wherever practical, the rehabilitation centers would be developed at the district level as well as at higher referral centers.

PREVENTION

In the initial phase, the main focus will be upon prevention and control of alcohol related problems. Later on,

addictions, juvenile delinquency and acute adjustment problems will be brought into the ambit. Community leaders and PHC medical officers would be actively involved in this activity.

Training of PHC Staff

With the inclusion of mental health in primary health care, the MPWs and MOs in the PHC are now trained for the following:⁸

MPWs

- Early recognition of all severe mental disorders and epilepsy in the community
- Referral of the identified patients to the primary health centers
- Regular follow-up of such patients in the community, with feedback to the doctors at the PHC
- Education and motivation of the patient's family members and neighbors to look after the patient humanely
- Management of psychiatric emergencies, e.g. acute excitement, when no doctor is available.

MOs

- Diagnosis and management of severe mental disorder, both acute and chronic
- Referral of difficult cases for specialist opinion to district hospitals and receiving them back for further follow-up
- Supervision and guidance of multipurpose workers.

Budget

The Planning Commission allocated Rs. 1.00 crore for implementing the program during the 7th plan.

National Institute of Mental Health and Neuro Sciences (NIMHANS), Bangalore, has been entrusted the job for preparing the necessary manuals related to the program.

World Mental Health Day: 10th October

To enhance treatment and promote mental health, the following initiatives have been taken under National Mental Health Program:¹¹

- District Mental Health Program extended to 123 districts.
- Upgradation of psychiatric wings of 86 medical colleges or general hospitals.
- Modernization of 29 mental hospitals.
- Mass media awareness campaigns.
- Research in mental health.
- Short-term training in mental health.
- Manpower development by establishment of centers of excellence and postgraduate training departments in mental health.

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Health Services through General Practitioners

General practice forms the backbone of the health care delivery system. The private doctor and hospital are the biggest providers of health services in India. Today there are more than 7 lakh doctors (Allopathic, RMPs, Ayurvedic, Unani, etc.) in India, out of which about 6 lakh work in the private sector.

About two-thirds of allopathic doctors are in general practice. In addition, the majority of the medical practitioners registered with State Councils of Homeopathy, Ayurveda, Unani, Sidha, etc. are in general practice. Also, there are a large number of traditional healers of medicine rendering some sort of health care to the people.

In a comprehensive study of health care practices in Jalgaon rural and urban area, it was found that when persons fell ill, 77 percent went to a private doctor or hospital and only 13 percent went to a government facility (hospital, dispensary, PHC or subcenter). Out of the remaining 10 percent, 2 percent went to traditional healers (including Vaidya, Hakim, folk healer, etc.). Two percent took self medication and 6 percent took no treatment.

What is General Practice?

The Indian Medical Association has defined general practice in medicine as a discipline adopted by a qualified medical man, called a General Practitioner (GP's), who for the purpose of alleviation of human ailment and suffering and for the promotion of human health, makes use of all branches of medical science, without restricting to any particular speciality.

According to the American Academy of General Practice, a General Practitioner is a legally qualified doctor of medicine who does not limit his practice to a particular field of medicine. He refers the patient to a particular specialist or consults him when the situation exceeds the capacities of his own training and competence.

The College of General Practitioners of Great Britain describes a General Practitioner as—"A doctor in direct touch with patients who accepts continuing responsibility for providing or arranging their general medical care which includes prevention and treatment of any illness or injury affecting the mind or any part of the body." According to the Australian College of

General Practitioners, 'A General Practitioner is directly responsible for the complete and continuous medical care of a patient and his family in all its aspects, providing technical services, when necessary, with the assistance of the appropriate consultant. To discharge this responsibility fully, the General Practitioner must understand and give attention to the mental, social and physical factors which determine the patient's reaction to his environment.'

General Practice vs Family Medicine

Till recently, general practice implied treatment of the individual. Over the last few years, it has been redesignated as family medicine and general practitioners are now known as family physicians. The practitioner in family medicine treats the family as a 'unit of living' or 'unit of illness'.

The family physician or family doctor knows all details above the family. Thus, he is in a unique position to base his approach to comprehensive care, including promotive, preventive, curative and rehabilitative aspects, upon his knowledge of the family environment. It should be remembered that the family is the smallest unit of social organization or community and it is here that the maximum interaction occurs between a person and his surroundings. For the purpose of discussion in this chapter, the term general practice and family medicine will be used as synonyms.

General Practice vs Community Medicine

Community medicine has been defined in the first chapter. As a discipline of medicine, it teaches the study of man in health or disease (not of disease in man) and helps in finding solutions to health or disease problems not only in the setting of a clinic or hospital but also in the community setting. General practice and community medicine are thus overlapping and not exclusive of each other. However, while Community Medicine/Preventive and Social Medicine places much emphasis upon epidemiology and health services administration, the emphasis, instead, in Family Medicine/General Practice is upon primary health care, both preventive and curative, management of emergencies and referral in time.

General practitioner, the doctor of first contact, plays a major role in the health care delivery system of any country. Because of marked socioeconomic and scientific advancement, the community in general, and families of patients in particular, expect a lot from him as regards receiving complete and continuous medical care. He has to answer questions like when to marry and when to have children as well as several other questions related to family planning, termination of pregnancy, genetics, psychiatry and geriatrics, etc. In order to prepare general practitioners to meet the needs of the community, separate departments of general practice should be established in medical colleges. As an initial step, these may be established as a unit within the existing departments of Community Medicine or Preventive and Social Medicine, as at the Mahatma Gandhi Institute of Medical Sciences, Sewagram, Wardha. These departments can provide academic training in family medicine practice in three ways:

1. *Family follow-up*: Medical students should be allotted a few families in the community at the beginning of their medical studies. They should be responsible for their comprehensive health care till the final MBBS examination under the supervision of their teacher.
2. *General outpatient department (GOPD)*: This should be established at the medical college hospital as rather the replica of a good Primary Health Center. The following functions are carried out here:
 - Health care, both preventive and curative, is given at primary level
 - Emergencies are attended to
 - Referral is made to various specialities in the hospital.

At the MGIMS, Wardha, the General Outpatient Department functions under the administrative responsibility of the Community Medicine Department, whose staff provides guidance to the students and interns working in the GOPD.
3. *Extended internship*: At least 6 months out of one year internship should be devoted to training in general practice. For this purpose, the interns should be posted for a combined total period of at least six months at the PHC, the GOPD or, even, the clinic of a general practitioner.

Components of Family Medicine or General Practice

The three essential components are primary care, emergencies and referrals. These are described here in detail, so as to give an idea about how much clinical medicine a student of MD in Community Medicine or Preventive and Social Medicine must know. This is based on the premise that every public health man or community

medicine specialist must be potentially a good general practitioner.

Primary Care

Training in primary care has two distinct aspects, curative and preventive.

CURATIVE ASPECTS

- The family physician has to blend art and science in a judicious manner. He has to win the confidence of patients and has to develop a good doctor—family relationship.
- He should be able to diagnose and treat common ailments of children and adults, including women. He should also be capable of managing common mental disorders.
- He should be able to perform minor general surgery and minor obstetric, pediatric, eye and ENT surgery.
- He should develop a good clinical sense and should be able to diagnose illness with the help of minimal laboratory tests. He should have a laboratory for routine urine, blood and stool tests. However, ECG, X-rays and other sophisticated laboratory tests should be left to be carried out by the specialists.
- He should realize that his patient being a part of the family and his family being a part of the society or community, the family and the community are related to the disease.

The family physician should learn to examine the case as a whole and not to jump at the diagnosis on the basis of one or two symptoms or isolated laboratory reports, X-rays or ECG, etc. He must learn to carry out a systematic and scientific follow-up of his cases. He should not delay referrals for financial gains. He should continue to develop professional competence and knowledge about the latest developments in prevention and treatment by reading professional journals and books. He should not criticise the practices followed by practitioners in indigenous systems but should rather win their cooperation. *Integration of the indigenous medical systems with modern scientific medicine* has, in fact, been advocated as a strategy of health care for the masses.¹ He should utilise his skills to overcome cultural barriers in the way of health care delivery.

PREVENTIVE ASPECTS

- The general practitioner should be able to give correct advice to the public regarding various immunizations and to administer (or to arrange for administration of) the same.
- He should know the procedure for registration of births and deaths.
- He should be able to give suitable advice on maternal and child care.

- The general practitioner should give suitable advice about methods of family planning and should help his clients to get these services free through state agencies.
- He should be familiar with the provisions and objectives of the Medical Termination of Pregnancy Act and should help women to avail of this facility in an easy and graceful way.
- He should make use of all services available under National Health Programs, such as those for control of malaria, tuberculosis, leprosy and goiter. General practitioners are often ignorant about their role in passive surveillance of malaria; this is a glaring example of their poor skill as GP. Any patient will be impressed if his blood slide is examined free and he is given radical treatment. Similarly, a GP will make a good impact on the community and the patients if he gets for them the drugs for treatment of tuberculosis and leprosy.
- He should have a practical knowledge about nutrition and its role in promotion of health and prevention and control of disease, especially in the vulnerable groups.
- The general practitioner should know whom to notify the cases of certain communicable diseases.
- Last, but not the least, is his vital role in health education. He should strike the iron when it is hot. The patient and the family are most receptive at the time of illness. A general practitioner can deliver health education in a more effective manner than a public health man.

Emergencies

The General Practitioner should be trained in handling all types of emergencies—medical, surgical or obstetric—till the patient gets cured, relieved or removed to a specialist or hospital.

COMMON SURGICAL EMERGENCIES

- *Accidents and injuries:* He should be able to treat vasovagal or neurogenic shock, give IV fluids, apply stitches and, of course, render first aid of all sort.
- *Acute abdomen:* He should be able to decide how to give immediate management and when and how urgently to send the patient to the surgeon. For example, severe pain lasting more than 6 hours, rigid abdomen, silent abdomen, distension and low blood pressure are pointers for immediate referral to a surgeon while acute abdomen associated with diarrhea, dysentery, indigestion, intestinal colic and renal colic can be managed by antispasmodics, etc.
- *Foreign bodies:* Foreign bodies in the ear, nose and throat, as well as in the eyes, are a common emergency, especially in children. The general practitioner must be able to deal with them.

COMMON MEDICAL EMERGENCIES

- *Anaphylactic shock:* This can follow administration of sera and vaccines and certain parenteral or even oral drugs. The general practitioner can save precious lives if he is familiar with immediate administration of adrenaline, hydrocortisone and aminophylline, etc. The patient should be asked to wait for 15 to 30 minutes if there is possibility of anaphylaxis following the administration of a particular substance.
- *Coma:* It could be a medical or surgical emergency or both and may be due to cardiovascular accidents, diabetes, poisoning, hepatic failure, uremia, meningitis and electrolyte imbalance. A general practitioner can be quite helpful in such a situation if he tries to correctly diagnose the cause of coma using his own knowledge, clinical acumen and common sense. In addition to putting the patient in lateral position, pulling out the tongue and giving artificial respiration, he can administer IV fluid in dehydration and can perform stomach wash for poisoning.
- *Myocardial infarction:* Morphine (15 mg), pethidine (100 mg), sedatives and oxygen are the immediate needs. The general practitioner should know when and how to give these and when and where to refer.
- Bronchial asthma.
- Cerebrovascular stroke.
- Poisoning due to chemicals, drugs, etc.
- Encephalitis, meningitis, tetanus.
- Status epilepticus.
- Snake and scorpion bites.
- *Miscellaneous:* urticaria, hyperpyrexia, heat stroke, etc.

COMMON OBSTETRIC EMERGENCIES

Common ones that a general practitioner may come across are: vaginal bleeding, incomplete abortion, toxemia of pregnancy, sepsis, prolapsed cord or hand and abnormal presentation and position. Obstructed labor may result in tear of cervix and rupture of uterus. A general practitioner should be trained in carrying out normal delivery, forceps delivery and episiotomy, as also in management of other obstetric conditions till the case is referred to hospital.

COMMON PEDIATRIC EMERGENCIES

These include diarrhea, dehydration, hyperpyrexia, convulsions and severe dyspnea associated with acute respiratory infection.

Referrals

A patient may have to be referred to higher level for proper diagnosis and management. This may be necessary in the following types of cases:

- When emergency treatment in hospital is required.
- When diagnosis is not clear.
- When there is possibility of a serious condition, such as cancer, especially when treatable.
- When the patient is not responding to the GP's treatment.
- When a second opinion is desired, either by the GP himself or the patient.
- When the services of a specialist are required for management of a known condition, e.g. surgery for cataract, enlarged prostate, cleft palate, medical termination of pregnancy and tubectomy, etc.

Community Skills Needed in a General Practitioner/Family Physician

A doctor who wishes to be successful in general practice in a community has to develop certain skills, not so much for any monetary gains but for the sake of his own inner satisfaction and for meeting total needs of the community. Such needs are better understood if a doctor reflects upon his own needs and desires. For himself and his family, a doctor wants promotion of health and prevention of disease through good housing, environmental sanitation, nutrition, MCH care, immunization and early attendance to any deviation from health. The very same are the needs of other individuals and families in the community in which he practices. For meeting such needs in a developing rural or urban society like ours, the skills used in general practice vary from doctor to doctor. Some of these skills are inherent in the doctor; others, he acquires from

early social environment at home or school and later from his medical training. He modifies or has to modify his methods to be successful in his mission when he faces the problems of health and disease in general practice. The major *community skills needed by a family physician* are listed below:

- He must know his community. Many diseases have their origin in the family or the community. Moreover, communities follow different practices in illness about which he must be aware.
- He must know about the health practices and procedures in other systems of medicine prevalent in the community. He also must be knowledgeable about the various health services available, whether indigenous or modern.
- He must be knowledgeable about various national health programs and should be able to encourage and guide the community, so as to make these programs successful.
- He should acquire skills, aptitude and expertise for health education and should provide the same in all possible situations.
- He should be human and humanistic in his approach. Though mentioned last, this is the most important community skill needed in general practice.

Reference

1. Gupta MC. Integrated Medicine: Prospects and Perspectives. In: Gupta MC (Ed). Nutrition in General Practice. Delhi: National Integrated Medical Association, 1983;83-86.

Health of the people in a country cannot be isolated from health of mankind in general. This is clear from the following examples:

- Diseases spread from one country to another. Examples are syphilis, plague, cholera, influenza and AIDS. Syphilis was earlier known as 'Firangi Rog' because it was believed to have been brought to India by the Europeans.
- Research, knowledge and developments in the field of health should not be confined to any one country but should, rather, be freely available to the whole mankind.
- Poor health conditions in a country are associated with and lead to poor development. The marked disparity between the developed and underdeveloped countries is a danger for world peace.
- Population explosion in the world has to be contained if the human race has to survive. There are countries in the world with near zero population growth, while there are many countries with very high rates. The former cannot remain silent spectators to the high birth rates in many parts of the world when the survival of mankind itself is at stake.

Hence international cooperation in health, including joint efforts at pollution control, is desirable.

It is obvious from the above that health and disease of people in one country are related to health and disease in other countries. This necessitates the need for international cooperation in the area of health. Attempts at such cooperation have been made through different agencies before the creation of the WHO after the Second World War. At present, the international cooperation in health is being largely effected through the WHO and other UN agencies. Bilateral government agencies and several non-government organizations also play a significant role in international health.

Pre-WHO Efforts

International Sanitary Conference (1851)

The first international efforts, directed towards evolving uniform quarantine regulations, were in the form of the International Sanitary Conference, 1851, in which many European countries participated, along with Turkey. The conference lasted six months and resulted in an international sanitary code comprising 137 articles dealing

with cholera, plague and yellow fever.¹ This code was ratified by only three countries and hence never came into force. Ten more conferences between 1851 and 1902 tried to reach an agreement in this direction, but all resulted in failure.

Pan American Sanitary Bureau (1902)

This was the first international health agency of the world established in 1902 to coordinate quarantine procedures among the various American countries. The Pan American Sanitary Code evolved by it in 1924 is still in force. In 1947, the PASB was renamed as Pan American Sanitary Organization (PASO). In 1940, it was agreed that the PASO would function as the WHO Regional Office for the Americas. In 1958, the name was changed from PASO to Pan American Health Organization.

International Health

PAHO is based in Washington DC. PAHO member states include all 35 countries in the America. A major effort of PAHO was the launch of polio eradication in 1985. In September 1994, the Americans were officially declared polio-free.

Office Internationale d'Hygiene Publique (1907)

After the American countries formed the PASB, other countries also felt the need to have a permanent health agency to disseminate information about communicable diseases and to evolve uniform quarantine procedures. This resulted in the establishment of the Office Internationale d'Hygiene Publique in Paris in 1907 comprising more than 60 countries.² The OIHP was wound up in 1950, after the WHO was established in 1948.

Health Organization of the League of Nations (1923)

The League of Nations was established after the First World War to ensure peace and stability in the world. However, it was unable to prevent the Second World War and was thus a political failure. It established a Health Organization in 1923 which carried out

commendable work in the field of health, hygiene, nutrition, housing, standardization of biologicals and training of public health workers. Efforts to amalgamate it with the PASB and OIHP did not succeed and the three continued to exist separately. In 1939, the League of Nations was dissolved but the activities of its Health Organization did not stop completely. It continued to publish the Weekly Epidemiological Records, which it had started, till this responsibility was taken over by the WHO.

World Health Organization

After the Second World War, the United Nations Organization (UNO), was established in 1945 to maintain world peace and security. It was proposed by some member countries of UNO that an international health organization should be established. An international health conference was held in New York in 1946 to draft the constitution of the proposed organization. The constitution was ratified by member states by April 7, 1948, on which day the WHO officially came into existence. This day is hence celebrated every year as the World Health Day.

Each year, the Organization selects a key global health issue and organizes international, regional and local events on the Day and throughout the year to highlight the selected area (**Table 36.1**).

World Health Day 2010: Urbanization and Health–1000 cities, 1000 lives

- 1000 cities: To open up public spaces to health, whether it be activities in parks, town hall meetings, clean-up campaigns, or closing off portions of streets to motorized vehicles;
- 1000 lives: To collect 1000 stories of urban health champions who have taken action and had a significant impact on health in their cities.

World Health Day 2011: Antimicrobial resistance: no action today, no cure tomorrow

Antimicrobial resistance is not a new problem but one that is becoming more dangerous; urgent and consolidated efforts are needed to avoid regressing to the pre-antibiotic era. For World Health Day 2011, WHO introduced a six-point policy package to combat the spread of antimicrobial resistance.

World Health Day 2012: Aging and health: Good health adds life to years

Aging concerns each and every one of us – whether young or old, male or female, rich or poor – no matter where we live. Over the past century life expectancy has increased dramatically and the world will soon have more older people than children (Average life expectancy in India is 64.7 years, 63.2 years for males and 66.4 years for females). Aging populations occur

everywhere, but less-developed countries are witnessing the fastest change. This social transformation represents both challenges and opportunities. In particular, countries may only have a single generation to prepare their health and social systems for an aging world. The focus is how good health throughout life can help older men and women lead full and productive lives and be a resource for their families and communities.

TABLE 36.1: Slogan of World Health Days for last 5 years

Years	World Health Days
2008	Protecting health from climate change
2009	Make hospitals safe in emergencies
2010	Urbanization and health - 1000 Cities, 1000 Lives
2011	Antimicrobial resistance: No action today, no cure tomorrow
2012	Aging and health: Good health adds life to years

Constitution

It was mainly drafted by Dr Rene Sand of Brussels, a pioneer of social medicine, and Dr Brock Chisholme, a Canadian psychiatrist who became the first Director General of WHO. The main objective of the WHO was stated as “the attainment of the highest level of health by all” which is basic to the happiness, harmonious relations and security of all peoples. *The objectives of the WHO* are further reflected in the preamble to the constitution as follows:

- ‘Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity’. ‘The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic or social condition.’
- ‘The health of all peoples is fundamental to the attainment of peace and security and is dependent upon the fullest cooperation of individuals and States.’
- ‘The achievement of any State in the promotion and protection of health is of value to all. Unequal development in different countries, in the promotion of health, control of disease, especially communicable disease, is a common danger’.
- ‘Health development of the child is of basic importance; the ability to live harmoniously in a changing total environment is essential to such development.’
- ‘The extension to all peoples of the benefits of medical, psychological and related knowledge is essential to the fullest attainment of health.’ Informed opinion and active cooperation on the part of the public are of the utmost importance in the improvement of the health of the people.
- ‘Governments have a responsibility for the health of their peoples which can be fulfilled only by the provision of adequate health and social measures.’

Organizational Structure

The WHO consists of three principal organs: the World Health Assembly (akin to a Parliament), the Executive Board (akin to the Cabinet) and the Secretariat. The WHO has six regional offices or organizations in different parts of the world.

There are 191 member states in the WHO and 2 associate members. The six regions of the WHO and the number of countries in each region are as follows:

Region	No. of member countries
Africa	46
The Americas	35
Eastern Mediterranean	22
Europe	51
South East Asia	11
Western Pacific	28

WORLD HEALTH ASSEMBLY

It is the supreme governing body of the organization and consists of delegates of the Member States, each of whom carries one vote. The Assembly meets every year in May, usually at Geneva. It may also hold meeting at other places. For example, the Fourteenth Assembly met in Delhi in 1961. The main task of the Assembly is to determine international health policy and programs. It also appoints the Director General on the recommendation of the Executive Board. Technical discussions are also held on some topic of global interest.

EXECUTIVE BOARD

It consists of 32 members, each designated by, but not representing, a member state. The members must be technically qualified in the field of health. Out of the 32 members, at least three must be elected from each of the six WHO regions.^{3,4} One-third members retire each year. The Board meets twice a year, in January and in May, soon after the World Health Assembly. The task of the Board is to give effect to the policies and decisions of the Assembly. It can also take action on its own in situations of emergency.

SECRETARIAT

The WHO Secretariat is the administrative wing of the WHO headed by the Director-General. It comprises about 5000 international public servants working in 14 divisions and¹³ programs listed below:

Divisions

1. Division of Epidemiological Surveillance and Health Situation and Trend Assessment
2. Division of Communicable Diseases

3. Division of Vector Biology and Control
4. Division of Environmental Health
5. Division of Public Information and Education for Health
6. Division of Mental Health
7. Division of Diagnostic, Therapeutic and Rehabilitative Technology
8. Division of Strengthening of Health Services
9. Division of Family Health
10. Division of Noncommunicable Diseases
11. Division of Health Manpower Development
12. Division of Information Systems Support
13. Division of Personnel and General Services
14. Division of Budget and Finance.

Programs

1. Health and Biomedical Information Program
2. Malaria Action Program
3. Parasitic Diseases Program
4. Expanded Program on Immunization
5. Diarrheal Diseases Control Program
6. Program for External Coordination
7. Special Program for Research and Training in Tropical Diseases
8. Special Program of Research, Development and Research Training in Human Reproduction
9. Action Program on Essential Drugs
10. Special Program on AIDS
11. Pharmaceuticals
12. Health for All Strategy Coordination
13. Office of Research Promotion and Development.

The WHO Secretariat provides technical and managerial support to member states for planning and implementing their national health programs. Besides the Director-General, the Secretariat also has five assistant Director-Generals, under whom the various divisions listed above are placed.

The first Director-General of WHO was Dr Brock Chisholm, a man of wide vision. The message that he conveyed to each member of the secretariat is as follows, "We must think and act in terms of mankind as a whole. We must be ready to give up old ideas, certainties and devotions in order to place the welfare of all people everywhere on the same level of values, regardless of where on this little earth one happens to have been born himself. In other words, we must try to attain an equal degree of loyalty to all members of the world community, irrespective of race, religion and color and any group characteristics."

The current Director-General is Dr Gro Harlem Brundtland.

REGIONAL OFFICES

Most of the executive powers regarding health matters are vested with the Regional Directors in the following six Regional Offices of the WHO:

1. Alexandria (Egypt) for Eastern Mediterranean Region
2. Manila (Philippines) for Western Pacific Region
3. Delhi (India) for South-East Asia Region, covering Indonesia, Mongolia, Myanmar (Burma), Thailand, Sri Lanka, Bangladesh, Democratic Peoples Republic of Korea, India, Maldives, Nepal and Bhutan. The first Director of the SEARO was Dr C Mani (India), succeeded by Dr Gunaratne (Sri Lanka) in 1968. The next Director, Dr U Koko, from Myanmar (Burma) joined in 1982 and functioned till 1993. He was followed by a Director from Indonesia. The current Director is from Thailand.
4. Copenhagen (Denmark) for European Region
5. Brazzaville (Congo) for African Region
6. Washington, DC for American Region (Pan American Health Organization, PAHO).

Functions of WHO

HEALTH SERVICE DEVELOPMENT

It strengthens the health services of Member States on request. This is the first time in history that international help is available to a State in the form of experts, personnel, drugs, transport, and equipment. India has received such help for control of communicable diseases (malaria, tuberculosis, leprosy, VD, cholera, smallpox, etc.) and in the fields of health, statistics, family planning, MCH, nutrition, health education, mental health and AIDS, etc. The WHO helps to improve the standards of teaching and training in health, medical and related professions by granting fellowships to doctors of one country for study and training in another country.

BIOMEDICAL RESEARCH

The WHO encourages and facilitates research by (i) giving grants and fellowships, (ii) standardizing nomenclature, laboratory techniques and substances like sera, vaccines and drugs. It has published an International Pharmacopeia and has set-up several International Reference Laboratories.

PREVENTION AND CONTROL OF SPECIFIC DISEASES

This activity covers both communicable and non-communicable diseases. Among communicable diseases, a large variety has been tackled by the WHO. The more important among these are: malaria, filaria, smallpox (now eradicated), tuberculosis, leprosy, diarrheal diseases and AIDS. The WHO maintains an epidemic intelligence service which collects and disseminates information about epidemics. WHO has set-up a uniform set of International Health Regulations regarding immunization and quarantine of travellers to prevent international spread of disease. During recent years, the WHO has

placed a major emphasis on six target diseases through the Expanded Program of Immunisation, aimed at immunization of all children by 1990.

As regards noncommunicable diseases, the WHO has given special attention to cardiovascular, neoplastic, mental, genetic and dental disorders, as also to drug addiction.

HEALTH STATISTICS

The WHO lays down uniform procedures for reporting, registration and collection of health and vital statistics. It publishes the "International Classification of Diseases, Injuries and causes of Death" which is revised every 10 years. The ninth revision became effective on 1.1.1979. The WHO also publishes (a) Weekly Epidemiological Record, (b) World Health Statistics Quarterly, and (c) World Health Statistics Annual to disseminate information in this area.

COOPERATION WITH OTHER AGENCIES

It promotes international cooperation in health through other special agencies of UN, such as UNICEF, FAO, ILO, etc. It also maintains contact with other organizations like CARE and USAID.

FAMILY HEALTH

Since 1970, the WHO has given a major emphasis to its Family Health Program, the aim of which is to improve the quality of the family as a unit. The components of this program are MCH, human reproduction, nutrition and health education.

ENVIRONMENTAL HEALTH

The WHO advises the Member States about provision of basic sanitary services and safe water supply, as also about prevention of air pollution. The WHO is committed to the target of "Water for All by 1990" set up by Habitat, the UN Center for Human Settlements.

HEALTH LITERATURE AND INFORMATION

The WHO acts as a clearing house for information on diverse health problems. It maintains a well-stocked library at the headquarters and brings out many publications. The important ones are listed below:

- Bulletin of WHO (Monthly), which publishes original work
- WHO Chronicle
- Weekly Epidemiological Report
- World Health Statistics (Quarterly and Annual Reports)
- World Health (Monthly)
- WHO Technical Report Series on different subjects
- WHO Monograph Series
- International Digest of Health Legislation
- World Health Forum.

Other UN Agencies

The UN was established on 24th October 1945 by 51 countries. The name United Nations was devised by the then United States President Franklin D. Roosevelt. The UN membership today is 189 nations. UN members are sovereign countries. The UN is not a world government and it does not make laws. The UN has six main organs. Five—the General Assembly, Security Council, Economic and Social Council, Trusteeship Council and the UN Secretariat are based at New York while the International Court of Justice is located at the Hague, Netherlands.

The International Monetary Fund, the World Bank group, and twelve other independent organizations known as “specialized agencies” are linked to the UN through cooperative agreements. Through UN efforts, governments have concluded hundreds of multilateral agreements that make the world a safer, healthier place with greater opportunity and justice for all of us. The Universal Declaration of Human Rights proclaimed by the General Assembly in 1958 sets out basic rights and freedoms to which all men and women are entitled.

One of UN’s central mandates is the promotion of higher standards of living, full employment and conditions of economic and social progress and development. As much as 70% of the work of UN revolves around accomplishment of this central mandate.

Other UN agencies specially active in the area of health include UNICEF, FAO, UNDP, ILO and World Bank. The United Nations University, with headquarters in Tokyo, promotes global research and understanding in several areas including health and nutrition.

UNICEF

The United Nations International Children’s Emergency Fund was established by the UN in 1946 to provide help and relief to children in countries where the Second World War had caused wide damage. In 1953, it was renamed as United Nations Children’s Fund but the abbreviation UNICEF was retained.

The UNICEF has the following offices:

- UNICEF Headquarter Office at New York
- UNICEF Regional Office for Europe at Geneva
- UNICEF Regional Office for Eastern and Southern Africa at Nairobi
- UNICEF Regional Office for West and Central Africa at Abidjan
- UNICEF Regional Office for the America and the Caribbean at Bogota
- UNICEF Regional Office for East Asia and the Pacific at Bangkok
- UNICEF Regional Office for the Middle East and North Africa at Amman
- UNICEF Regional Office for South Asia at Kathmandu

- UNICEF Regional Office for Central and Eastern Europe, Commonwealth of Independent States and Baltic States at Geneva
- UNICEF Office for Japan at Tokyo.

India falls under the South Asia region along with Bangladesh, Bhutan, Pakistan, Afghanistan, Nepal, Sri Lanka and Maldives.

FUNCTIONS

During its earlier years of functioning, the UNICEF worked in close collaboration with WHO and sponsored the BCG campaign, campaigns against VD and malaria, and the distribution of skimmed milk. Later, it started supporting in a big way the programs related to maternal and child health, nutrition, health education and environmental sanitation, including water supply. The recent tendency on the part of UNICEF is to give more emphasis on integrated maternal and child health programs. In India, the Integrated Child Development Service (ICDS), has received substantial inputs from the UNICEF. The EPI (Expanded Program of Immunization) is also supported by the UNICEF. Primary Health Care, ORT (management of diarrhea through oral rehydration therapy) and promotion of breastfeeding are some of its other areas of interest. The UNICEF has also provided support for programs aimed at controlling goitre, anemia and xerophthalmia.

The four areas of special emphasis by the UNICEF are child health, child nutrition, family and child welfare and education. The UNICEF has also played an important role in the field of water supply and sanitation. The UNICEF also proposes to play a more positive role in family planning.

FAO

The Food and Agricultural Organization, with its headquarter in Rome, was established in 1945 with the main objective of raising food production and ensuring adequate food availability in the face of increasing population. It plays special attention to the rural areas, where it aims at increasing the efficiency of farming, fisheries and forestry. In order to combat malnutrition, the FAO launched in 1960 the Freedom from Hunger campaign. The FAO is also linked to the World Food Program (WFP) and works in close collaboration with the WHO. The WHO and FAO have jointly sponsored a large number of expert committees on food and nutrition, the recommendations of which have been published as Technical Report Series of the WHO/FAO. The FAO also shares interest in control of brucellosis and other zoonoses.

Since 1994, FAO has undergone major restructuring. The reforms include increased emphasis on food security, increased use of experts from developing countries and broadened links with the private sector and nongovernmental organization.

UNDP

The United Nations Development Program was established in 1966 to strengthen natural and human resources for national development. Its projects include several areas in economic and social sectors, including industry and agricultural as well as health and education. UNDP has generally served as the central planning, funding and coordinating agency for technical cooperation and operational activities related to development in India on behalf of the entire UN system. It works in collaboration with the United Nations Children's Fund (UNICEF), the United Nations Population Fund (UNFPA), the International Trade Center (ITC), the World Food Program (WFP) the International Labor Organization (ILO), the Food and Agriculture Organization (FAO), the United Nations International Drug Control Program (UNDCP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Health Organization (WHO) United Nations AIDS Program UNAIDS and the United Nations Industrial Development Organization (UNIDO) all of whom are represented in the country.

UNDP is the UN's principal provider of development advice, advocacy and grant support, UNDP is helping developing nations plan and implement nationally owned strategies and solutions for reducing poverty. UNDP is also helping developing countries prepare, fund and implement strategic HIV/AIDS plans that mobilize all sectors of government and civil.

ILO

The International Labor Organization, with its headquarter in Geneva, was founded in 1919 to improve the working and living conditions of workers in different countries. With this aim in view, the ILO has framed an International Labor Code prescribing minimum standards for health and welfare of workers and their working and living conditions. It collaborates with the WHO in the field of health and labor.

World Bank

The World Bank (International Bank for Reconstruction and Development) was established in 1944 to raise the standard of living in the less developed countries. It gives loan for projects that are aimed at economic growth. Its projects are diverse, including electricity, transport, water supply, agriculture, health, welfare and population control.

The World Bank is owned by 183 member countries. The World Bank group is the world's largest source of development assistance. It works in more than 100 developing countries with its primary focus

of helping the poorest people in the poorest countries. The Bank provides nearly 16 billion US dollars every year in loans to its client countries. Currently, in India, the World Bank is supporting the two largest programs in the health sector anywhere in the world. These are the National Program for Control of Blindness and the National AIDS Control Program.

UNFPA

The United Nations Fund for Population Activities carries out programs in over 130 countries and territories. The Fund's aims are to build up capacity to respond to the needs in population and family planning. It promotes awareness of population problems in both developed and developing countries at their request and helps them in dealing with population problems. More than 25% of the assistance to developing countries for population related activities is channelled through UNFPA.

UNFPA began operations in 1869. UNFPA has three main program areas: Reproductive Health including Family Planning and Sexual Health; Population and Development strategies and Advocacy.

UNESCO

The United Nations Educational, Scientific and Cultural Organization was formed in 1945 and currently has 188 members. The main objective of UNESCO is to contribute to peace and security in the world by promoting collaboration among nations through education, science, culture and communication. In 2000 AD, its budget was 400 million US Dollars. UNESCO publishes the World Education Report annually.

UNHCR

The United Nations High Commission for Refugees was established in 1950 to provide protection and assistance to refugees. Refugees are legally defined as people who are outside their countries of origin because of a well founded fear of persecution based on their race, religion, nationality, political opinion or membership in a particular social group, and who cannot or do not want to return home. As a humanitarian nonpolitical organization, UNHCR has two basic aims—to protect refugees and to seek ways to help them restart their lives in a normal environment. In addition to refugees, there are an estimated 20 to 25 million internally displaced persons, i.e. people who have fled their homes generally during a civil war, but have stayed in their home countries. UNHCR also helps these internally displaced persons. Health care is also an integral part of such operations of UNHCR.

UNIDO

The United Nations Industrial Development Organization helps developing countries in their fight against marginalization in today's globalized world. UNIDO was set up in 1966 and became a specialized agency of the United Nations in 1985.

UNAIDS

UNAIDS is a joint United Nations Program on HIV/AIDS. The partners in this joint program include UNICEF, UNDP, UNFPA, UNDCP, UNESCO, WHO and the World Bank. Specific global targets addressing an expanded response to the HIV/AIDS epidemic are the main activity of the organization. The Intercountry Office for the South Asia Region is based at New Delhi.

Bilateral Agencies

Colombo Plan

This was conceived at a meeting of Commonwealth Foreign Ministers in Colombo in 1950. It consists of a group of 20 developing countries in South and South East Asia and 6 developed countries (USA, UK, Canada, Australia, New Zealand and Japan). The assistance to member countries is mainly aimed at agricultural and industrial development. Some funds are earmarked for health also. Health activities in India related to Colombo Plan have included supply of cobalt therapy units by Canada and establishment of the All India Institute of Medical Sciences at New Delhi through financial assistance from New Zealand. Many fellowships for training of health personnel have also been provided from time to time.

USAID

The United States Agency for International Development, established in 1961, provides assistance to a large number of countries in the world. It has supported several health programs in India, including control of malaria and other communicable diseases, water supply and sanitation, family planning, nutrition and medical and nursing education. Prior to establishment of USAID, the US assistance was channelled through the Technical Cooperation Mission. Two other US agencies providing assistance are:

1. Public Law 480 (Food for Peace) Program
2. US Export Import Bank.

USAID is currently providing massive assistance to AIDS/HIV control in India. The APAC Project in Tamil Nadu and the AVERT project in Maharashtra are funded

by USAID through the National AIDS Control Organization.

DANIDA

Danish International Development Assistance is funded by the Government of Denmark. It has supported many major activities in India in relation to health and education. DANIDA is currently supporting three major health programs in India—DANLEP (Danida Assisted National Leprosy Eradication Program) was launched in 4 districts in three State of Madhya Pradesh, Orissa and Tamil Nadu in 1986. DANLEPs multipronged strategy consists of infrastructural support, health education, human resource development, program monitoring and prevention and care of deformities; DANPCB (Danida Assisted National Program for Control of Blindness) which was initiated in 1978. It is currently in the third phase of extension. In the first phase primary health center infrastructure strengthening was the objective while in the second phase human resource development and decentralization by setting up District Blindness Control Societies was the major input. The third phase is continuing the gains of the earlier two phases and it is proposed to set up a National Eye Care Resource Center through this assistance; DANTB (Danida Assisted Revised National Tuberculosis Control Program) was initiated in 1996. Phase I end in 2001 but DANIDA has already committed to support a second phase for a further period of five years.

DFID

The Department for International Development is the organization channelizing British government assistance. The main objective of DFID is the global effort to eliminate world poverty in the 21st century. These targets include halving the proportion of people living in extreme poverty by 2015. The other objectives of DFID include achieving universal primary education by 2015, making progress towards gender equality and empowering women by eliminating disparities in primary and secondary education by 2005, reducing infants and child mortality rates by two-thirds by 2015, reduce maternal mortality ratios by 3/4th by 2015 and implement national strategies for sustainable development by 2005. DFID activities are focused in 4 States in India—Madhya Pradesh, Andhra Pradesh, Orissa and West Bengal. In the health sector DFID is supporting reproductive health services, control of HIV/AIDS, tuberculosis control, community eye care and polio eradication.

Other bilateral government agencies active in India are the Swedish, Canadian, and Norwegian Agencies for International Development.

Nongovernment Agencies

Rockefeller Foundation

This philanthropic organization was established in USA in 1913 by Mr John D Rockefeller. Its activities in India began in 1920 when it supported a scheme aimed at control of hookworm disease in Chennai. It has given substantial aid to Virus Research Center, Pune, All India Institute of Medical Sciences, Delhi, All India Institute of Hygiene and Public Health, Kolkata and several medical colleges, especially those at Vellore, Ludhiana and Lucknow. It also offers scholarships for advanced training of health professionals. It is providing active support to promotion of family planning, medical education and agriculture in India. It is currently supporting R and D for drugs for TB and AIDS in a big way. It has spent more than two billion dollars since its inception. Since its inception more than US 10 billion has been spent for grants and aid.

Ford Foundation

It was founded in 1936. It has provided assistance in various areas in health, some of which are listed below:

- Water supply and drainage in Kolkata.
- Orientation and training in public health by establishing:
 - Three centers at Singur, Poonamalle and Najafgarh for training of medical and paramedical personnel
 - National Institute of Health Administration and Education (NIHAE) which, after merger with the Central Family Planning Institute, has been redesignated as National Institute of Health and Family Welfare (NIHF).
- Family planning
- Environmental sanitation (particularly, development of hand flushed latrines for rural areas).

CARE (Cooperative for American Relief Everywhere)

It is a voluntary organization, set up in 1946 to help war sufferers in Europe. Now it operates in other countries too. Its operations began in India in 1950. The largest CARE activity in India is the midday meal scheme for primary school children. It has provided help in other areas also such as agriculture, medicine and education.

During the year 2000, more than 8 million people in 13 countries received food through school feeding programs, food for work programs and community kitchens, 9.2 million women and children benefited from

mother and child health projects in 23 countries, 3.1 million people gained access to clean water and sanitation services in 31 countries and 5.1 million people in 26 countries benefited from health services including STD/HIV prevention activities.

Red Cross

It owes its origin to Henry Durant, a Swiss businessman, who was moved by the intense suffering and neglect of wounded soldiers in the battle of Solferino, North Italy in 1859. He campaigned widely for establishment of a voluntary society which would render aid to those wounded in war, without distinction of nationality. He proposed that such a society should have a protective emblem, so that its services in war could be protected by international treaty.

As a result of Durant's efforts, the First Geneva Convention was held in 1864 and the International Committee of the Red Cross (ICRC) was formed, which was the founder organization of the Red Cross. It has branches all over the world.

In 1919, the League of the Red Cross Society was established, with headquarter at Geneva, for the purpose of coordinating the work of National Red Cross Societies which now number more than 90. The Red Cross Society of India was established in 1920 by an Act of Indian legislature. Its objectives were improvement of health, prevention of disease and mitigation of suffering. Its activities include:

- Provision of amenities to soldiers in time of war.
- Organizing disaster relief services in times of flood, famine, earthquake, etc. in the form of distribution of milk, medicines, vitamins, clothes, blankets, etc.
- Maintaining blood banks and promoting blood donation for the benefit of those wounded in wars or disasters.
- Development of maternity and child welfare services.
- Maintaining the Red Cross Home in Bangalore for disabled ex-serviceman.
- Providing amenities like newspapers, periodicals, musical instruments, etc. to patients in military hospitals.

Freedom from Hunger

This is an international development organization working in 14 countries across the globe. It brings innovative and sustainable self-help solutions to the fight against chronic hunger and poverty. It was established in 1946.

Agha Khan Foundation

It was founded in 1967 by His Highness the Aga Khan. The foundation works in 11 countries including India.

The overall program focuses on four major development areas—health systems, education including early childhood care and development, rural development and income generation to alleviate poverty and NGO enhancement.

Save the Children Fund

This UK based charity works in more than 70 countries. It was founded in 1919 to provide emergency relief to children suffering from malnutrition as a consequence of the First World War. Health care, education and welfare are the three main areas of work of this organization.

Oxfam

Oxfam is a confederation of autonomous NGO's committed to fight poverty and injustice in the world and work in many developing countries including India.

Development activities and advocacy are the main planks of the work carried out by Oxfam.

Others Voluntary Organizations

Besides the above, there are many other international voluntary organizations doing very good work in the field of health. Some of these are listed below:

- Population Council
- International Planned Parenthood Federation
- International Leprosy Association
- International Agency for the Prevention of Blindness
- International Union against Cancer
- World Federation of the Deaf.

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4. WHO: WHO Chronicle, 1977;31:492.

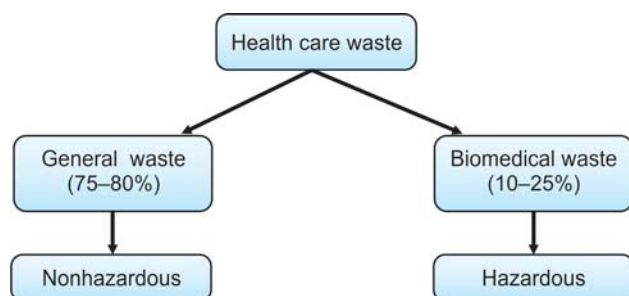
Environmental pollution has been discussed in Chapter 10 of the book in detail. This additional write up is meant to focus on the newly emerging concern of biomedical waste management with special reference to medical waste management, which has assumed special importance because of the fear of spread of certain infections, particularly HVB, HVC and HIV infections.

A special attribute of biomedical waste is that even though it forms only a small part of the total solid waste, if not taken care of properly, it can pollute the whole of the solid waste and thereby transfer infectivity to the whole of the municipal solid waste. Once that happens, all the waste must be considered infected and treated as such. Not only this, if the biomedical waste finds access to air and water, it has the potential of infecting the ambient environment as well as water sources and channels.

Concept and Definition

Health Care Wastes

Waste that is generated from any health care establishments, research facilities and laboratories due to various health care activities is known as health care waste. Majority, i.e. 75 to 80% of health care wastes are general wastes and nonhazardous; but rest 10 to 25% wastes are hazardous, which is referred as biomedical waste.



Biomedical Wastes

Biomedical waste means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production of testing of

biologicals and including human anatomical waste, animal waste, microbiology and biotechnology waste, waste sharps, discarded medicines and cytotoxic drugs, solid wastes, liquid waste, incineration ash, chemical waste, etc.¹⁻³

Medical Wastes

Medical waste includes the various types of biomedical wastes related to medical use. These are as follows:

- Pathological waste (human tissues such as limbs, organs, fetuses, blood and other body fluids).
- Infectious waste (soiled surgical dressing, swab material in contact with persons or animals suffering from infectious diseases, waste from isolation wards, cultures or stocks of infectious agents from laboratory, dialysis equipment, apparatus and disposable gowns, aprons, gloves, towels, etc.).
- Sharps (any item that can cut or puncture such as needles, scalpels, blades, saws, nails, broken glass, etc.).
- Pharmaceutical waste (drugs, vaccines, cytotoxic drugs and chemicals returned from wards, outdated drugs, etc.).
- Chemical waste (any discarded solid, liquid or gaseous chemicals from laboratories, cleaning, disinfection, etc. hazardous chemicals that are corrosive, flammable, reactive, genito-toxic, etc. non-hazardous chemicals such as inorganic salts, buffer chemicals, amino acids, sugars, etc.).
- Aerosols and pressurized containers
- Radioactive waste.

Importance and Nature of Biomedical Waste

Biomedical waste assumes significance because this is generated throughout the country in hospitals, nursing homes, maternity homes, pathological laboratories, dentists, private medical practitioners, etc. The number of facilities generating biomedical waste is quite large. In Mumbai alone, their number is estimated to be 15000. Biomedical waste has assumed special importance in view of the risk of spread of HIV AIDS and Hepatitis B through exposure to discarded needles, syringes and other medical waste from municipal garbage bins and disposal sites. Rag pickers try to

salvage any discarded material and sell it to make a living. These rag pickers themselves are also exposed to the risk of injuries from contaminated needles and other sharp objects.²

If not properly and safely disposed, biomedical waste causes an adverse impact on human health. A large number of hospitals, nursing homes, pathology laboratories and health care centers situated in urban areas do not take adequate measures for the safe disposal of biomedical wastes. Such wastes often get mixed with domestic solid waste and finally get deposited at domestic waste disposal dumpsites. Many large hospitals dispose of their mixed wastes within the hospital premises, where waste remains unattended in the open for a long time. Some hospitals and nursing homes have set up low-temperature incineration plants for the disposal of wastes, which are often not well maintained and do not function efficiently.

The quantity of hospital waste generated depends upon the type of waste generating facility. As per a study from Bangalore,⁴ the quantity of biomedical waste generated per bed per day is given in **Table 37.1**.

The total hospital waste generated per day in Bangalore was estimated to be 50 tonnes per day, of which 45 to 50 percent was infectious. This high proportion of infectious waste is probably due to the fact that segregation was practiced only in 30 percent hospitals.

The above proportion needs to be compared to the actual amount of infected waste at point of generation. Data from the National Environmental Research Institute, Nagpur [1997], shows the following pattern of composition of hospital waste in India **Table 37.2**.

According to the Indian Society of Hospital Waste Management,⁵ the quantum of waste generated in India is estimated to be 1 to 2 kg per bed per day in a hospital and 600 gm per day per bed in a general practitioner's clinic, out of which only 5 to 10 percent consists of hazardous/infectious waste.

TABLE 37.1: Quantity of biomedical waste generated per bed per day

Private nursing homes	0.5 – 1
Private hospitals	0.5 – 2
Government hospitals	0.5 – 4

TABLE 37.2: Composition of hospital waste in India

Metal [Sharps, etc.]	1%
Infectious waste	1.5%
Glass	4%
Plastics	10%
Paper	15%
Rags	15%
General [Food waste, sweepings from hospital premises, etc.]	53.5%

Health Hazards Associated with Poor Hospital Waste Management

In general, these may be listed as below:

- Risk of mechanical injuries from sharp waste material to all categories of hospital personnel and waste handlers.
- *Risk of infections:* (a) Inside the hospital through contamination with sterilized equipment and appliances and dressings, etc. (b) Outside the hospital for waste handlers, scavengers and rag pickers, etc. (c) Eventually, to the general public; (d) Change in microbial ecology and spread of antibiotic resistance further add to the above risks.
- Risk of chemical injury associated with hazardous chemicals, drugs, being handled by persons handling wastes at all levels.⁶

Role of Disposable and Autodisable Syringes (AD Syringes)

Besides body tissues and fluids and dressings, etc. an important component of hospital waste is the disposable syringes. These are meant for one time use but it is well known that they are often retrieved from the waste and recycled for repeated use after cursory washing and repackaging, thus helping in the spread of serious infections. Additionally, plastic syringes add to non-biodegradable waste.

Correct Use of AD Syringes

At first, correct syringe for the vaccine (BCG 0.1 ml and all others 0.5 ml) is chosen. After that packing is checked, and if it is found damaged, opened, or expired, then the syringe is discarded. Thereafter the package is opened from the plunger side and syringe is taken out by holding the barrel. Needle cover or cap is then removed. Both the packaging and needle cover are discarded into a black plastic bag. Plunger of the needle is not moved until one is ready with syringe to draw the vaccine. Air is not injected into the vial as this will lock the syringe. Then needle is inserted into the inverted vial through the rubber cap, such that the tip is within the level of the vaccine. If inserted beyond, then air bubble might be trapped inside the syringe, which is very difficult to expel. Needle or the rubber cap of the vial is never touched.

Then plunger is pulled back slowly to fill the syringe and the plunger will automatically stop when the necessary dose of the vaccine has been drawn (0.1 or 0.5 ml). If air is trapped inside the syringe, then needle is removed from the vial and by holding the syringe upright, barrel is tapped to bring the bubbles towards the tip of syringe. Then plunger is pushed to the dose mark (0.5 or 0.1 ml), by expelling the air bubble. At last,

after cleaning the injection site, vaccine is administered by pushing the plunger completely. Injection site is never rubbed after administration of vaccine.

Disposal of Biomedical Waste

Segregation

The first step in proper disposal is systematic segregation of the waste. Infectious and non-infectious wastes are generally not segregated at source and instead the mixed (often wet) waste is taken to the incineration plant in a very unhygienic manner. The system of collection, transportation and disposal of biomedical waste is thus not scientifically designed.⁷

ADVANTAGES OF SEGREGATION

These are as follows:

- It prevents mixing of infectious with noninfectious waste, thus minimizing the high cost and care involved

in disposal of infectious waste. Once such mixture occurs, the total amount has to be treated as infectious.

- It reduces the chance of accidental infection of health care workers and waste handlers.
- It allows rapid disposal of infectious waste which should not be kept within the hospital premises for long time. Besides the obvious risk of spread of infection, there is a possibility that storage of infected waste for longer periods may be conducive to emergence of mutants which may be more hardy and resistant.

CATEGORIES FOR SEGREGATION

These have been prescribed by the government³ as per Schedule 1 of the Biomedical Waste (Management and Handling) Rules, 1998, announced by the Ministry of Environment and Forest and are given in **Table 37.3**.

COLOR CODING SCHEME

The purpose of segregation is to help in appropriate disposal of waste as necessary depending upon the

TABLE 37.3: Categories of biomedical waste in India

Option	Waste category	Treatment and disposal
Category No. 1	Human anatomical waste (human tissues, organs, body parts)	Incineration ² /deep burial
Category No. 2	Animal waste (Animal tissues, organs, body parts carcasses, bleeding parts, fluids, blood and experimental animals used in research, waste generated by veterinary hospitals colleges, discharge from hospital, animal house)	Incineration ² /deep burial
Category No. 3	Microbiology and biotechnology waste (Waste from laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, waste from production of biologicals, toxins, dishes and devices and for transfer of cultures)	Local autoclaving/microwaving/incineration ²
Category No. 4	Waste sharps (Needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	Disinfection (chemical treatment@/ autoclaving/microwaving and mutilation/shredding)
Category No. 5	Discarded medicines and cytotoxic drugs (Wastes comprising of outdated, contaminated and discarded medicines)	Incineration@ destruction and drugs disposal in secured landfills
Category No. 6	Soiled waste (Items contaminated with blood, and fluids including cotton, dressings, soiled plaster casts, linen, beddings, other material contaminated with blood)	Incineration@ autoclaving/microwaving
Category No. 7	Solid waste (wastes generated from disposable items other than the waste sharps such as tubings, catheters, intravenous sets, etc.)	Disinfection by chemical treatment@@ autoclaving/microwaving and mutilation/shredding ##
Category No. 8	Liquid waste (Waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities)	Disinfection by chemical treatment @@ and discharge into drains
Category No. 9	Incineration ash (Ash from incineration of any biomedical waste)	Disposal in municipal landfill
Category No. 10	Chemical used in production of biologicals, chemicals used in disinfection, as insecticides, etc.	Chemical treatment@@@ and discharge into drains for liquids and secured landfill for solids

@ @ Chemicals treatment using at least 1% hypochlorine solution or any other equipment chemical reagent. It must be ensured that chemical treatment ensures disinfection.

Mutilation/shredding must be such so as to prevent unauthorized reuse.

@ There will be no chemical pretreatment before incineration. Chlorinated plastics shall not be incinerated.

2 Deep burial shall be an option available only in towns with population less than five lakhs and in rural areas.

inherent risk and the mode of disposal. All the waste after segregation must be stored in color coded containers. The color coding scheme as prescribed³ is given in **Table 37.4**.

Storage

Medical waste requires to be stored on site at the place of generation until a large and adequate quantity is accumulated to warrant treatment or transportation to site of disposal. Often, in case of small waste generators, intermediate storage at a Common Area Facility [CAF] may be required since they themselves may not be in a position to treat their biowaste in their own treatment plants which, at any rate, would not only be too costly for small nursing homes and hospitals, but, may also be not environment friendly. For the purpose of carting biowaste to a CAF or to the treatment plant, there would be needed a special van, which, preferably, should be air conditioned. Adequate number of carting vans with frequent periodicity are needed to ensure that the waste does not remain on the premises beyond twelve hours as that would provide enough opportunity to the microbes to multiply and perhaps mutate, thus defeating the very purpose of preventing spread of hospital acquired infection. No untreated biomedical waste should be stored beyond a period of 48 hours.

Ideally, segregation and disinfection/sterilization of the infected waste should be carried out before the waste is carted to the CAF. If this is not done, scenario, the conversion of infected waste to nonharmful waste does not take place, the spread of nosocomial and hospital acquired infection may not be curbed.

Treatment

The treatment of biomedical waste is aimed at rendering such waste nonhazardous or less hazardous.

Methods Available for Treatment of Hospital Waste

Treatment is defined as a process that changes the character of hazardous waste to render them less hazardous or non-hazardous. Treatment renders waste unrecognizable and may or may not reduce volume. All waste treatment technologies have their advantages and disadvantages and no single method is applicable to all wastes. Hence, treatment depends upon the nature of the waste, technology that is technically and economically viable and environmentally safe and must meet public acceptance.

Different methods of treatment are very briefly described below:

- **Incineration:** This method is used only for such waste as cannot be disposed in landfill sites, has more than 60 percent combustible matter and does not have more than 5 percent noncombustible solids. Moisture content should be below 30 percent. It is a high temperature oxidation process.
- **Chemical disinfection:** The main use is to disinfect liquid waste or hospital sewage. Some types of solid waste may also be suitable for this purpose.
- **Microwave:** Microwave irradiation at 2450 MHz frequency and 12.24 cm wave length destroys most microorganisms.
- **Steam sterilization or autoclaving:** It is suitable only for specific types of infective waste. Anatomical waste, animal carcasses and chemical or pharmaceutical waste are not amenable to its use.

Methods Suitable for Different Types of Wastes⁸

- **Sharps wastes:** After the treatment with 1% hypochlorite solution for 30 minutes, they are disposed off in the safety pit.
- **Infectious wastes:** Disposal by incineration is preferred method. Autoclaving to render waste

TABLE 37.4: Color coding and type of container for disposal of biomedical wastes

Color coding	Type of container	Waste category	Treatment options as per schedule I
Yellow	Plastic bag	Cat. 1, Cat. 2, and Cat. 3, Cat. 6	Incineration/deep burial
Red	Disinfected container/ plastic bag	Cat. 3, Cat. 6, Cat. 7	Autoclaving/Microwaving/Chemical Treatment
Blue/White translucent	Plastic bag/puncture proof container	Cat. 4, Cat. 7.	Autoclaving/Microwaving/Chemical Treatment and Destruction/Shredding
Black	Plastic bag	Cat. 5 and Cat. 9 and Cat. 10 (solid)	Disposal in secured landfill

Notes:

1. Color coding of waste categories with multiple treatment options as defined as Schedule I, shall be selected depending on treatment option chosen, which shall be as specified in Schedule I.
2. Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.
3. Categories 8 and 10 (liquid) do not require containers/bags.
4. Category 3 if disinfected locally need not be in containers/bags.

noninfectious, and then disposal by domestic landfill. Small amounts of body fluids, if suitably diluted, can be disposed of in the normal sewerage system.

- *Cytotoxic waste*: Incineration using high temperature combustion is preferred method of disposal due to high toxicity. Low cytotoxic waste concentrations may be disposed of via the sewerage system once suitably diluted.
- *Chemical waste*: Mercury waste must not be incinerated due to resulting toxic emissions. Not to be disposed of via sewerage system. Mercury is used widely in dental work. Disposal of chemical waste into sewerage system may cause corrosion.
- *Radioactive waste*: If under limits provided by state legislation, may be disposed of by incineration, Sanitary landfill at an approved site, or by the sewerage system. Must consider possibility of radioactive gas on incineration.
- *Plastic wastes*: Incineration may cause toxic fumes. Reduction by compaction, and possible landfill.
- *Food waste*: Grinding or pulping, with disposal into the sewerage system or incineration.

Equipment Required in a Biomedical Waste Management Facility

It includes:

- Incinerator
- Autoclaves and microwaves
- Shredders
- Chimney
- Flue gas and cyclone filters
- Scrubbers
- Sterilizers
- Effluent treatment plant.

Individual vs Common Facility

Setting up a common facility has many advantages over an individual facility in each hospital. An individual hospital will have to spend time, money and energy on the following:

- *Land*: This is often scarce, especially in urban areas. Even otherwise, it is desirable that the land for setting up of a waste disposal unit should be away from habitation and should have a green belt around it.
- *Equipment*: These include incinerators, autoclaves, microwaves, shredders and an effluent treatment plant, which are quite expensive.
- *Operating cost*: Electricity, Diesel and Manpower costs are recurring expenses, over and above management time for managing the set-up.
- *Approval from the State Authorities and the Pollution Control Board*: It is quite a tedious and responsible task, with legal implications, to procure such approval and to maintain the treatment plant properly as per the laid down requirements so as to ensure periodic certification from the concerned authorities.

The advantage of a common facility over individual facility is clear from the following example.⁹ As per sample calculations, the capital cost of equipment for a 100 bed hospital having an individual facility would be Rs. 1.4 million or Rs. 14,000 per bed. On the other hand, if the same hospital is part of a common facility handling 10,000 beds, the capital cost of such a facility would be Rs. 15 million, which works out to only Rs. 1500 per bed.

Features of a Common Facility

- It should ideally be centrally located within its area of operation in order to minimize the distance traversed in waste collection, thus enhancing its operational feasibility.
 - The facility operator is responsible for the collection, reception, storage, transportation, treatment, disposal and/or any other form of handling of biomedical waste in accordance with the rules and guidelines issued by the Ministry of Environment and Forests.
 - The facility should have a fleet of vans and Light Commercial Vehicles (LCVs), needed for collection of the waste from the hospitals and for transportation of the same to the facility. Each vehicle should have different colored compartments, with each color denoting a particular kind of waste, so that different kinds of wastes are segregated and destroyed separately.
 - The final disposal of the biomedical waste should be in sanitary landfills to be constructed in a manner that would ensure conservation of groundwater quality, air and soil.
 - Incineration is the most important treatment method for destruction of all highly toxic wastes. Incinerators should be well designed and equipped to operate at high temperatures, and to have air pollution control devices to contain all gaseous, liquid and solid residues. High temperature incineration at 12000 Celsius mineralises (breaks down into basic nontoxic components) all kinds of organic matter. Incineration serves the dual purpose of reduction of both the toxicity and the volume of the waste, which is an important consideration when the disposal of wastes is finally destined for landfills. It is estimated that a single incinerator would have a capacity to manage around 10,000 beds or equivalently around 5000 kg/day (**Table 37.5**).
- However, it needs to be noted that there are certain reservations about incineration as a method of waste disposal, such as emission of air polluting toxic fumes. In some countries, such as Philippines, incineration as a method of disposal of biomedical waste has been banned by law, the Clean Air Act of 1999, or Republic Act 8749, under which 17 July 2003 was laid down as the last date by which hospitals must adopt non-burn methods of waste disposal.¹⁰
- Typically, each facility would service institutions within a radius of 100 km.

TABLE 37.5: Disposal of immunization waste

Categories of waste	Collected in	Disinfection by	Ultimate fate
<ul style="list-style-type: none"> • Cut hub of autodisable and disposable syringe • Broken vials and ampoules 	Syringe hub cutter	1% hypochlorite solution for 30 minutes #	Disposed in safety pit
<ul style="list-style-type: none"> • Plastic part of syringes • Empty unbroken vials 	Red bag @	1% hypochlorite solution for 30 minutes #	Recycled
<ul style="list-style-type: none"> • Needle caps • Wrappers 	Black bag @	-	Disposed as municipal wastes

@ Red or black plastic bags are biodegradable, and is made up of virgin, nonchlorinated polymer material with a minimum thickness of 55 micron. # 1% Hypochlorite solution is prepared by dissolving 10-15 g or 1 tablespoonful of bleaching powder in 1 liter of water. Freshly prepared diluted solution is used daily, since chlorine solution gradually loses its strength.

Safety Pit or Tank for Disposal of Treated Needles and Broken Vials

The treated needles and broken vials are disposed off in a circular or rectangular pit. It is a dug pit, having a length 1 to 2 m and depth 2 to 5 m and is lined with brick, masonry or concrete rings. The pit is covered with a heavy concrete slab, which is penetrated by a galvanized steel pipe projecting for about 1 meter above the slab, with an internal diameter of up to 50 millimeters or 1.5 times the length of vials, whichever is more. The top opening of the steel pipe have a provision of locking after the treated waste sharps have been disposed in. When the pit is full it can be sealed completely, after another pit has been prepared.¹¹

Use of Syringe Hub Cutter (Fig. 37.1)

After the use, needle and hub of autodisable (AD) or disposable syringe is inserted into the insertion hole. By holding the syringe in same position, the hub is completely cut by using the clamp in other hand. The cut needle and hub will drop automatically inside the syringe hub cutter. In addition, broken vials and ampoules are also kept inside the container of hub cutter. These are ultimately disposed off in safety pit.¹¹



DISPOSAL OF GENERAL WASTE

General waste that is being generated in the health care settings is collected in a black bin followed by black bag. Then it is transported by black trolley and stored in black

vat. Ultimately from the black vat it is disposed off with municipal garbage.

Biomedical Wastes (Management and Handling) Rules, 1998

The Government of India under the provision of the Environment Act 1986 notified the Biomedical Waste Management and Handling rules on 20th July 1998 (BMW Rules'98). The Rules regulate the disposal of biomedical wastes, including human anatomical waste, blood and body fluids, medicines and glassware, soiled, liquid and biotechnology wastes and animal wastes. The objective is to take all steps to ensure safety of health and environment.

The rules delineate the duty of occupiers in the treatment and disposal of Biomedical Wastes. Biomedical Wastes (BMW) have been classified into 10 categories and the treatment and disposal options for each of the categories are specified in Schedule I. The treatment and disposal should be in compliance with the standards prescribed in Schedule V. Schedule V gives standards for incinerators (operating and emission standards), for waste autoclaving, for liquid waste, of microwaving and for deep burial.

Prescribed authorities such as State Pollution Control Boards and Pollution Control Committees to grant authorization to hospitals are defined in the rules. An Advisory Committee is to advise the prescribed authority on the implementation of the rules. A schedule for implementation of BMW rules has been laid down in Schedule VI.

Authorization has been made mandatory to all occupiers generating biomedical wastes excluding occupiers of clinics, dispensaries, pathological laboratories, blood bank, by whatever name called, providing treatment/service to less than 1,000 (one thousand) patients per month which need not obtain authorization. The Rules also provide for provisional authorization for a trial period for one year.

The Biomedical Waste Rules make the generator of wastes liable to segregate, pack, store, transport and

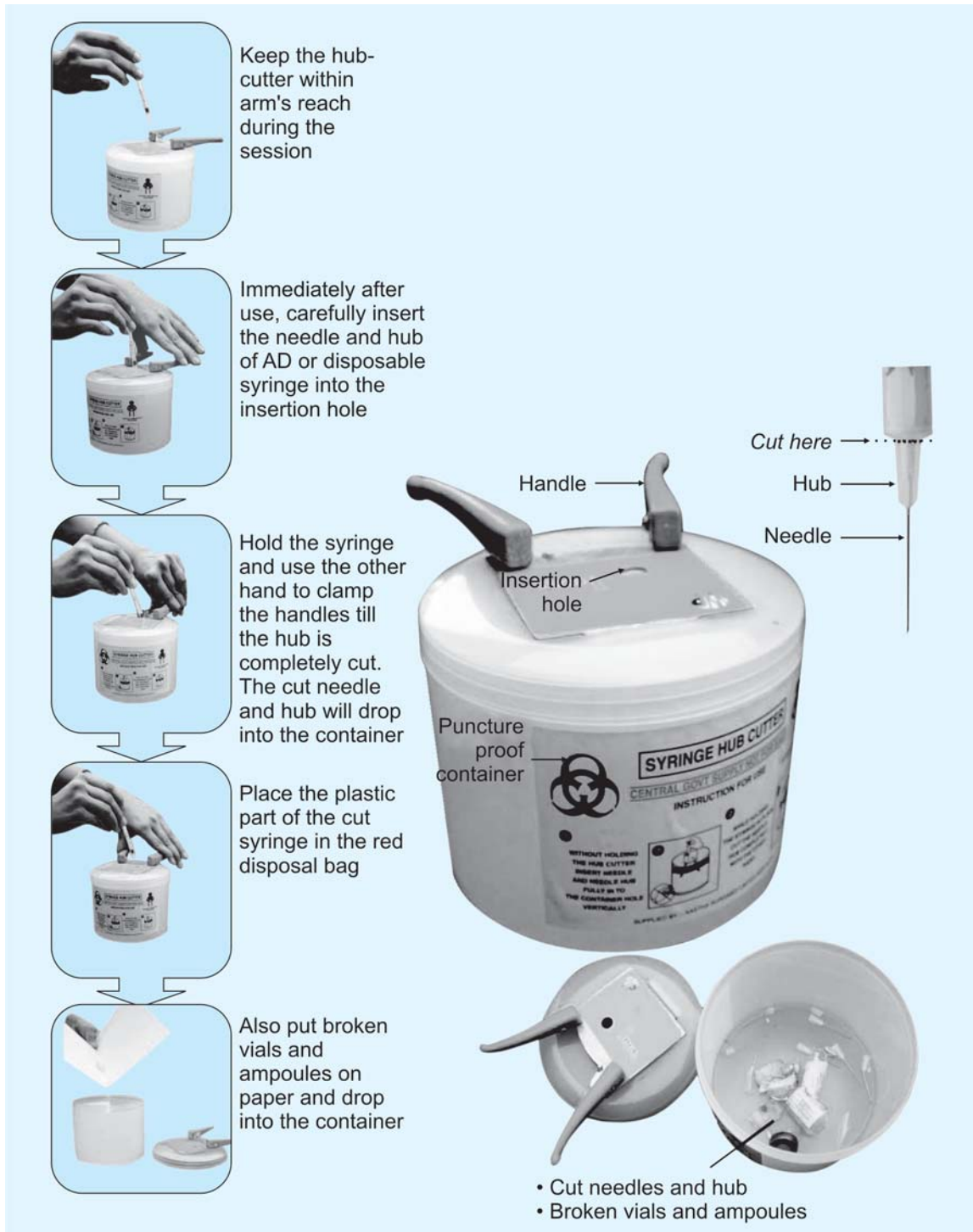


Fig. 37.1: Use of syringe hub cutter¹¹

dispose off the biomedical wastes in an environmentally sound manner.

The agency responsible for implementation of the Rules is the prescribed authority to be constituted by each State Government/UT. The tasks of the administering agencies include the grant of authorization, record keeping, monitoring the handling of wastes and accidents, and of supervising the implementation of rules.

The details pertaining to the types of containers to be used, their color coding and labeling have also been provided in these rules. Recycling and reuse of biomedical wastes except plastics and glassware have been prohibited.

The advisory committee will advise the prescribed authority as and when required. This will ensure the participation of medical and health, animal husbandry

and veterinary sciences, environment management, municipal administration and NGOs. The committee will also ensure participation of the State Pollution Control Boards (SPCBs) and Pollution Control Committees. This will help in the implementation of these rules.

The Rules have been formulated as a framework for handling and management of biomedical wastes. The Rules are applicable to all persons handling biomedical wastes. The duty of the occupiers is absolute.

In order to comply with the Biomedical Waste (Management and Handling) Rules, 1998, a policy on hospital waste management which lays down the requirements for hospital waste management from the point of generation to its final disposal and establishes managerial responsibilities should be formulated.

Article 21 of the Constitution of India guarantees the right of life and personal liberty. The expansive interpretation given to it by the judiciary includes the fundamental right to clean environment with health and medical care within its ambit.

The Central Legislations on this subject are: -

- The Water (Prevention and Control of Pollution) Act, 1974
- The Air (Prevention and Control of Pollution) Act 1981.
- The Environment (Protection) Act 1986
- The Hazardous wastes (Management and Handling) Rules 1989
- The Biomedical Wastes (Management and Handling) Rules 1998
- Municipal Solid Wastes (Management and Handling) Rules 2000 for Municipal Wastes

As per the feedback given by CPCB, the implementation of various provisions of the BMW Rules is far from satisfactory.

Awareness campaigns are necessary to inform small clinics and dispensaries to undertake proper management of BMW. Several states have successfully launched such awareness drives through audio-visual media. Ministry of Environment and Forests has also appointed professional agencies to launch mass awareness campaign through electronic and print media on a number of subjects including BMW. Training of hospital staff towards proper segregation of biomedical wastes is also necessary.

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Anthrax

Anthrax has been already described in Chapter 20. The present description has been given in addition to that already given. It has been compiled in view of the fact that anthrax has been used as a bioterrorism tool and, therefore, detailed information on its manifestations, diagnosis, prevention and treatment is necessary. It may be mentioned that in 2001, *Bacillus anthracis* spores had been intentionally distributed through the postal system in USA, causing 22 cases of anthrax, including 5 deaths.¹

The information given below has largely been based on data available with the Center for Disease Control, USA.¹ It has been presented in an easy to read question-answer form.

What are the Types of Anthrax Infection?

Anthrax infection can occur in three forms: cutaneous (skin), inhalation, and gastrointestinal.

CUTANEOUS

Most (about 95%) anthrax infections occur when the bacterium enters a cut or abrasion on the skin, such as when handling contaminated wool, hides, leather or hair products (especially goat hair) of infected animals. Skin infection begins as a raised itchy bump that resembles an insect bite but within 1 to 2 days develops into a vesicle and then a painless ulcer, usually 1 to 3 cm in diameter, with a characteristic black necrotic (dying) area in the center. Lymph glands in the adjacent area may swell. About 20 percent of untreated cases of cutaneous anthrax will result in death. Deaths are rare with appropriate antimicrobial therapy.

INHALATION

Initial symptoms may resemble a common cold—sorethroat, mild fever, muscle aches and malaise. After several days, the symptoms may progress to severe breathing problems and shock. Inhalation anthrax is usually fatal.

GASTROINTESTINAL

The intestinal disease form of anthrax may follow the consumption of contaminated meat and is characterized

by an acute inflammation of the intestinal tract. Initial signs of nausea, loss of appetite, vomiting, fever are followed by abdominal pain, vomiting of blood, and severe diarrhea. Intestinal anthrax results in death in 25 to 60 percent of cases.

What are the Case Fatality Rates for the Various Forms of Anthrax?

CUTANEOUS ANTHRAX

Early treatment of cutaneous anthrax is usually curative, and early treatment of all forms is important for recovery. Patients with cutaneous anthrax have reported case fatality rates of 20 percent without antibiotic treatment and less than 1 percent with it.

INHALATIONAL ANTHRAX

Although case-fatality estimates for inhalational anthrax are based on incomplete information, the rate is extremely high, approximately 75 percent, even with all possible supportive care including appropriate antibiotics. Estimates of the impact of the delay in postexposure prophylaxis or treatment on survival are not known.

GASTROINTESTINAL ANTHRAX

For gastrointestinal anthrax, the case-fatality rate is estimated to be 25-60 percent and the effect of early antibiotic treatment on that case-fatality rate is not defined.

What are the Symptoms for Anthrax?

These symptoms can occur within 7 days of infection:

Fever (temperature greater than 100 degrees F): The fever may be accompanied by chills or night sweats.

Flu-like symptoms: Cough, usually a nonproductive cough, chest discomfort, shortness of breath, fatigue, muscle aches.

Sorethroat, followed by difficulty swallowing, enlarged lymph nodes, headache, nausea, loss of appetite, abdominal distress, vomiting, or diarrhea.

A sore, especially on face, arms or hands, that starts as a raised bump and develops into a painless ulcer with a black area in the center.

In most cases, anthrax can be distinguished from the flu because flu has additional symptoms like running nose.

*What is Postexposure Prophylaxis for Prevention of Inhalational Anthrax after Intentional Exposure to *B. Anthracis*?*

Prophylaxis for inhalational anthrax exposure lies in the use of either ciprofloxacin or doxycycline as first line agents. High-dose penicillin (e.g. amoxicillin or penicillin VK) may be an option for antimicrobial prophylaxis when ciprofloxacin or doxycycline are contraindicated.²

Is There a Vaccine for Anthrax?

A protective vaccine has been developed for anthrax; however, it is primarily given to military personnel. Vaccination is recommended only for those at high risk, such as workers in research laboratories that handle anthrax bacteria routinely. The antibiotics used in post exposure prophylaxis are very effective in preventing anthrax disease from occurring after an exposure.

Who should be Vaccinated Against Anthrax?

The US Advisory Committee on Immunization Practices (ACIP) has recommended anthrax vaccination for the following groups:

- Persons who work directly with the organism in the laboratory.

- Persons who work with imported animal hides or furs in areas where standards are insufficient to prevent exposure to anthrax spores.

- Persons who handle potentially infected animal products in high-incidence areas.

- Military personnel deployed to areas with high risk for exposure to the organism.

What is a Nasal Swab Test?

A nasal swab involves placing a swab inside the nostrils and taking a culture. The CDC and the US Department of Health and Human Services do not recommend the use of nasal swab testing by clinicians to determine whether a person has been exposed to *Bacillus anthracis*, or as a means of diagnosing anthrax. At best, a positive result may be interpreted only to indicate exposure; a negative result does not exclude the possibility of exposure. Also, the presence of spores in the nose does not mean that the person has inhalational anthrax. The nose naturally filters out many things that a person breathes, including bacterial spores. To have inhalational anthrax, a person must have the bacteria deep in the lungs, and also have symptoms of the disease.

Another reason not to use nasal swabs is that most hospital laboratories cannot fully identify anthrax spores from nasal swabs. They are able to tell only that bacteria that resemble anthrax bacteria are present.

If Patients are Suspected of Being Exposed to Anthrax, should they be Quarantined or should Other Family Members be Tested?

Direct person-to-person spread of anthrax is extremely unlikely and anthrax is not contagious. Therefore, there is no need to quarantine individuals suspected of being exposed to anthrax or to immunize or treat contacts of persons ill with anthrax, such as household contacts, friends, or coworkers, unless they also were also exposed to the same source of infection.

What should be the Management When a Person has been Exposed to Anthrax?

Identification of a patient with anthrax or a confirmed exposure to *B. anthracis* should prompt an epidemiologic investigation. The highest priority is to identify at risk persons and initiate appropriate interventions to protect them. The exposure circumstances are the most important factors that direct decisions about prophylaxis. Persons with an exposure or contact with an item or environment known, or suspected to be contaminated with *B. anthracis*: regardless of laboratory tests results: should be offered antimicrobial prophylaxis. Exposure or contact, not laboratory test results, is the basis for initiating such treatment.

Culture of nasal swabs is used to detect anthrax spores. Nasal swabs can occasionally document exposure, but cannot rule out exposure to *B. anthracis*. As an adjunct to epidemiologic evaluations, nasal swabs may provide clues to help assess the exposure circumstances.

Rapid evaluation of contaminated powder, including particle size and characteristics, may prove useful in assessing the risk for inhalational anthrax.

What Antimicrobial Treatment should be Given?

A high index of clinical suspicion and rapid administration of effective antimicrobial therapy is essential for prompt diagnosis and effective treatment of anthrax. Limited clinical experience is available and no controlled trials in humans have been performed to validate current treatment recommendations for inhalational anthrax. Based on studies in nonhuman primates and other animal and *in vitro* data, ciprofloxacin or doxycycline should be used for initial intravenous

therapy until antimicrobial susceptibility results are known.²

Because of the mortality associated with inhalational anthrax, two or more antimicrobial agents predicted to be effective are recommended; however, controlled studies to support a multiple drug approach are not available. Other agents with *in vitro* activity suggested for use in conjunction with ciprofloxacin or doxycycline include rifampin, vancomycin, imipenem, chloramphenicol, penicillin and ampicillin, clindamycin, and clarithromycin; but other than for penicillin, limited or no data exist regarding the use of these agents in the treatment of inhalational *B. anthracis* infection. Cephalosporins and trimethoprim-sulfamethoxazole should not be used for therapy.²

Penicillin is labeled for use to treat inhalational anthrax. However, preliminary data indicate the presence of constitutive and inducible beta-lactamases in the *B. anthracis* isolated in some cases, hence treatment of systemic *B. anthracis* infection using a penicillin alone (i.e. penicillin G and ampicillin) is not recommended.²

Toxin-mediated morbidity is a major complication of systemic anthrax. Corticosteroids have been suggested as adjunct therapy for inhalational anthrax associated with extensive edema, respiratory compromise, and meningitis.

Bioterrorism

Preparedness for and response to an attack involving biological agents are complicated by the large number of potential agents (most of which are rarely encountered naturally), their sometimes long incubation periods and consequent delayed onset of disease, and their potential for secondary transmission. In addition to naturally occurring pathogens, agents used by bioterrorists may be genetically engineered to resist current therapies and evade vaccine-induced immunity.³ A quick review of bioterrorism is presented below in the form of easy to read questions and answers.

What is Biological Warfare?

Biological warfare—also known as bioterrorism—is the intentional use of organisms to harm or kill people. Terrorists are most likely to use organisms that cause infectious diseases because they are easily spread among people.

WHAT DISEASES POSE THE BIGGEST THREATS?

Experts on biological warfare regard anthrax and smallpox as the biggest hazards, although terrorists could use many other disease-causing organisms.

Other organisms such as *Yersinia pestis*, *Brucella tularensis*, *Clostridium botulinum* and *M. tuberculosis* could pose a potential bioterroristic threat. Hemorrhagic fevers have also been suggested as a bioterror threat.³ However, experts believe that all these organisms are unlikely to cause widespread disease because they are difficult to manufacture and distribute. They are also less hardy than anthrax.

WHAT IS COMPARATIVE THREAT FROM ANTHRAX AND SMALLPOX AS TOOLS OF BIOTERRORISM?

Smallpox was eradicated from the world in 1977. Three years later, the World Health Assembly recommended an end to routine vaccination, and most countries complied. Hence, many people have never been vaccinated for smallpox and no one knows whether those who received vaccinations 25 or more years ago are still protected. Public health experts also do not know whether supplies of old vaccine would work today. About 30 percent of those infected with the disease die of it.⁴

Smallpox is harder to propagate than anthrax and less tolerant of severe conditions. However, unlike anthrax, it can spread very rapidly from person to person. Also, not being a bacterial infection, smallpox is not amenable to antibiotics and there is no treatment for it.

It is notable that both anthrax and smallpox may be difficult to diagnose at first. Both may show signs and symptoms similar to those seen with flu, including fever, chills and muscle aches. Anthrax resulting from inhalation of spores is the form of illness that would likely occur with a bioterrorist attack. This illness would initially resemble a viral respiratory illness and then would progress to severe shortness of breath and hypoxia. With smallpox, a reddish rash appears first. It progresses to pocks (vesicles) that begin on the face and spread to the membranes in the mouth (oral mucosa), hands, forearms, lower extremities and finally the trunk.

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Nosocomial infections (Hospital Acquired Infections) refer to all types of infections acquired by the patients while being treated in hospital, as also by hospital staff members, volunteers, visitors, workers, salespersons and delivery personnel, etc. visiting the hospital or working there.¹ The concept of nosocomial infections may be related to the realization, almost around 150 years ago, in 1847, of Ignac F Semmelweis, then a young assistant to Johann Klein, a Professor of Obstetrics at University of Vienna, through a series of sharp clinical observations, that identified medical practices within hospitals are a major source and mode of spread of infections. He demonstrated that modification of such practices led to control of such infections.

Nosocomial infections continue to be a significant public health problem worldwide because of their frequency and the associated morbidity and mortality, as also the increase in cost of health care. In affluent countries the incidence of nosocomial infections ranges between 5 and 10 percent.² Urinary tract infections (UTIs) are the most common type of nosocomial infections in both acute care hospitals and long-term care facilities. These infections regularly account for about 40 percent of all hospital acquired infections and are a major source of nosocomial septicemia and related mortality.³ Nosocomial pneumonia is the next major group of infections after UTI.⁴ In the early 1990s, nosocomially acquired multidrug resistant tuberculosis (MDR-TB) presented a serious public health problem, initially in the USA, and soon thereafter, in Southern European Countries.

Nosocomial infections can occur from endogenous as well as exogenous source. Endogenous source involves translocation of resident microflora secondary

to a breach in host defense. Exogenous source involves transmission from patient to patient or from health care worker to patient. It can also occur after exposure of a susceptible patient to a contaminated environmental source like inadequately disinfected medical devices. Center for disease control (CDC) has come up with certain specific criteria including clinical and pathological findings, laboratory tests and imaging data for correct diagnosis and management of nosocomial infections.¹

Control Measures

- Handwashing with disinfectants—detergents.
- Hygienic handrubs—rubbing fast acting antiseptic preparations on to both hands.
- Surgical hand disinfections
- Perioperative antibiotic prophylaxis.⁵

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Chapter 21 dealing with noncommunicable diseases covers cancer, cardiovascular diseases, diabetes, accidents and blindness. It is felt that a brief account of oral diseases is called for because these form a significant part of morbidity and even mortality [through oral cancer]. Sufficient attention is often not paid to these because: firstly, with the exception of oral cancer, they often cause only local symptoms in the oral cavity, even though these may be quite irritating and painful; secondly, physicians are not often trained in their diagnosis or treatment as most conditions come under the purview of either dentists or ENT specialists. It is in view of the importance of this topic that the WHO has brought out a publication titled Tobacco and Oral Diseases,¹ mainly based upon two recent reviews.^{2,3}

Major Statements

The major statements regarding oral diseases that underline the basis and reason for the above monograph¹ deserve to be presented here at the outset so as to provide a backdrop for discussion of the oral problems of public health importance, with special reference to India.

- Oral cancer and precancer occur much more frequently in smokers than in non-smokers. Smoking cessation significantly decreases the increased risk of oral cancer within 5 to 10 years.
- Periodontal disease is increased both in prevalence and severity in smokers. Smoking cessation may halt disease progression and improve the outcome of periodontal treatment.
- Dental implant failure rates are significantly higher in smokers than in nonsmokers.
- Smoking often results in discolorations of teeth and dental restorations.
- Halitosis, diminished taste and smell acuity are common side effects of smoking.
- The entire dental team should be aware of the relationship between smoking and dental problems and should convey the message that nonsmoking is the norm.
- Smoking counseling should be a fundamental part of the dental curriculum and any practice prevention program.

Oral Cancer

The most common type of oral cancer is squamous cell carcinoma. Sixty percent of oral cancers are well advanced by the time they are detected, even though physicians and dentists frequently examine the oral cavity.⁴ The two most important risk factors for oral cancer are tobacco use and heavy alcohol consumption. The keys to reducing mortality are prevention and control. The earlier any intraoral or extraoral abnormalities or lesions are detected and biopsied, the more lives can be saved. Controversy exists whether screening programs effectively reduce the mortality rate.⁴ It is well known that oral cancer is much more common in India than in the West. Still, oral cancer accounts for approximately 3 percent of all cases of cancer in the United States.

As regards India, useful and reliable insights into etiology and risk of oral cancer in men and women is provided by an elaborately designed and analyzed case control study from three centers in South India comprising 591 cancer cases and matched 582 controls.⁵ Main findings were as below:

- Low educational attainment, occupation as a farmer or manual worker and various indicators of poor oral hygiene were associated with significantly increased risk.
- An OR [odds ratio] of 2.5 (95% confidence interval 1.4-4.4) was found in men for smoking > or = 20 bidi or equivalents versus 0/day.
- The OR for alcohol drinking was 2.2 (95% CI 1.4-3.3).
- The OR for paan chewing was more elevated among women (OR 42; 95% CI 24-76) than among men (OR 5.1; 95% CI 3.4-7.8). This male female difference was maintained when paan chewing with or without tobacco was analyzed.
- Among men, 35 percent of oral cancer was attributable to the combination of smoking and alcohol drinking and 49 percent to pan-tobacco chewing. Thus 84 percent oral cancer in men attributable to paan-tobacco chewing, smoking and alcohol.
- In contrast, among women, chewing and poor oral hygiene explained 95 percent of oral cancer.

In an earlier case control study from Tata Memorial Hospital,⁶ Rao et al found that in addition to chewing, smoking and drinking, nonvegetarian diet was also significantly associated with oral cancer.

A large case-control study of oral and pharyngeal cancer conducted in four areas of the United States provided information on the tobacco and alcohol use of 1114 patients and 1268 population-based controls. Because of the large study size, it could be shown that the risks of these cancers among nondrinkers increased with amount smoked, and conversely that the risks among nonsmokers increased with the level of alcohol intake. Among consumers of both products, risks of oropharyngeal cancer tended to combine in a multiplicative rather than additive manner and were increased more than 35-fold among those who consumed two or more packs of cigarettes and more than four alcoholic drinks/day. Cigarette, cigar, and pipe smoking were separately implicated, although it was shown for the first time that risk was not as high among male lifelong filter cigarette smokers. Cessation of smoking was associated with a sharply reduced risk of this cancer, with no excess detected among those having quit for 10 or more years, suggesting that smoking affects primarily a late stage in the process of oropharyngeal carcinogenesis. The risks varied by type of alcoholic beverage, being higher among those consuming hard liquor or beer than wine. The relative risk patterns were generally similar among whites and blacks, and among males and females, and showed little difference when oral and pharyngeal cancers were analyzed separately. From calculations of attributable risk, it was estimated that tobacco smoking and alcohol drinking combined to account for approximately three-fourths of all oral and pharyngeal cancers in the United States.⁷

Oral Precancer

Leukoplakia, the most common form of oral premalignancy occurs 6 times more frequently in smokers than in non-smokers. Oral leukoplakia is also associated with smokeless tobacco use. Cessation of tobacco use may result in regression or disappearance of oral leukoplakia.

The increase in cancer mortality throughout the world justifies the study of its causes and development. Hungary was found to have the highest mortality rate from oropharyngeal cancer out of forty-six countries studied.⁸ Cross-sectional studies show a higher prevalence rate of leukoplakia among smokers, with a dose-response relationship between tobacco use and oral leukoplakia, and intervention studies show a regression of the lesion after stopping the smoking habit.

In a large house-to-house survey in Ernakulam district, Kerala, covering 12,213 tobacco users, where persons were interviewed about the details of their

tobacco usage, it was found that the frequency of tobacco habit was associated with the prevalence of leukoplakia indicating a positive dose-response relationship. The dose-response relationship was stronger for the smoking habit than for the chewing habit.⁹

Oral Mucosal Diseases

Smoker's Palate

Smoker's palate is seen especially among heavy pipe-smokers and is asymptomatic and not premalignant. It disappears after cessation of smoking habit. However, palatal keratosis associated with reverse smoking as seen in some parts of the world, is a premalignant lesion. Reverse smoking is found in parts of Andhra Pradesh, especially in women, though it seems to be decreasing now.

In a study where smoking habits and their effect on the palatal mucosa leading to cancer, were studied in 324 villagers of Uppada, East Godavari District, (AP), the frequency of reverse smoking (i.e. smoking with the lighted end inside the mouth) was found to be 6.23 times higher in females than in males. The frequency of preleukoplakia was 2.26 times higher, that of leukoplakia was 13.84 times higher, and that of stomatitis nicotina was 7.13 times higher in reverse smokers than in regular smokers.¹⁰ These frequencies were lower compared to earlier studies done in the 60s and 70s in the districts of Visakhapatnam and Srikakulam.

Oral Candidiasis

During the past 20 years studies have shown that smoking, either alone or in combination with other factors appears to be an important factor for oral candidiasis. Among the other factors, dentures had significant effect. In a study comparing normal and completely edentate persons wearing dentures, *Candida* colonization was 36.8 percent and 78.3 percent in healthy dentate and complete denture wearing patients, respectively. In the healthy dentate subjects the tongue, palate and cheeks, and in complete denture wearers additionally the upper and lower dentures, were the most frequently and densely colonized oral sites.¹¹

Periodontal Disease

A clear association has been demonstrated between smoking and the prevalence and severity of periodontal disease, suggesting smoking as an important risk factor for periodontal disease. Smoking is associated with an increased disease rate in terms of periodontal bone loss, periodontal attachment loss, as well as periodontal

pocket formation. In addition, it exerts a masking effect on gingival symptoms of inflammation. Risk assessment based on an increasing body of investigations over the past few years suggests that the tobacco attributable risk is considerable, estimated odds ratios being of the order 2.5 to 6.0 or even greater.¹² It is thus clear that tobacco should be considered a major risk factor for chronic periodontal disease. It needs to be mentioned that besides smoking, Smokeless tobacco products and snuff have long been associated with local gingival recession.

Dental Caries

The gravity and importance of caries as a health problem can be gauged from the fact that 500 dental visits take place in USA every year and in spite of this large number, many US children and adults do not have access to dental care and, therefore, receive none. The majority of the dental visits are for caries. Tooth decay is one of the most common infectious diseases among US children. This preventable health problem begins early and is present in 20 percent US children by the age of 4 years; more than 50 percent by 8 years and more than 75 percent by 17 years. Among low-income children, almost half of cavities are untreated, and may cause pain, dysfunction, poor appearance, and underweight—problems that greatly reduce a child's capacity to succeed.¹³

History of the Caries Epidemic

Caries has widely afflicted mankind during last 250 years, mainly coinciding with the use of sucrose following the development of sugar cane industry in North America, and, later, sugar beet industry in Europe. A large proportion of people in the countries where sucrose became widely available developed rapidly-advancing dental caries which began in the tooth enamel.

Older Concepts and Approach to Treatment

Caries is a disease which progresses slowly and is asymptomatic in early stages. It is only in the later stages that the patient develops pain, severe localized infection within relatively dense bone and, later, even systemic illness.

Initially, it was thought that caries represents gangrene of tooth and, as per the prevalent surgical principles, it was thought best to remove the dead tissue, dental extraction was regarded as the standard treatment. Later, instead of routine extraction, local debridement was attempted with cleaning out the decayed area. After such local debridement, the area was left open to saliva. Still later, local removal and then filling the resultant cavity was also attempted. The early

fillings sealed badly and tended to fail within months, or a few years at most, because of continuing decay. Early fillings were metallic in nature, usually lead, tin or gold. Each of these metals could be pressed or hammered into the cavity. Pure gold was the most difficult of these metals to handle, but tended to last longer if it was very carefully placed. A mixture of silver and mercury, called dental amalgam, was also used to fill cavities. The mixture is initially soft, so it can be packed into the cavity with only moderate pressure, but hardens later because of chemical reactions between the silver and mercury.

The concept that caries was gangrene continued well into the 20th century, and treatment modalities continued to be guided by this belief, even till the present time. However, improvement in technology of scraping and filling the cavities ultimately resulted in a situation where most qualified dentists in the latter half of twentieth century started preferring restorative approach to extraction.

Complete removal of carious enamel and dentin was thought to be an essential part of successful filling design. Restorative materials did not adhere to teeth. In order for them to stay in place decayed areas had to be modified in shape.

In the 1950s, the concept that caries was caused by acids produced by bacterial action on residual food on and around the teeth became widely accepted. Brushing teeth after meals to remove residual food was widely advocated as a preventive strategy but had little effect on caries rates. Advising patients to change their food choices and to eat less often was a rational approach, but few individuals took that advice.

In the 1970s, the concept that caries was caused by dental plaque became widely accepted. Patients were advised to brush and floss teeth to remove plaque. The epidemiological discovery that fluoride intake influenced caries and, later, demonstration that caries experience was reduced by topical application of led to the dietary fluoride supplements in children, water fluoridation and the use of topical fluorides in dentifrices, rinses and gels. The combination of fastidious plaque removal and fluoride use was shown to be effective in reducing caries in individuals and in whole populations.

A later development was the use of polymeric materials which bonded to enamel and thus sealed fissures. Fissures are areas of high likelihood for caries initiation in individuals who have the disease. Sealed fissures have a greatly reduced incidence of caries initiation.

Present Concepts

There is now very strong evidence that the disease is not gangrene. There are therefore strong grounds to change the ways that the disease is treated.

A large body of data shows that caries is the progressive loss of tooth mineral, followed by bacterial invasion into the demineralized tooth. It is a relatively complex disease. The nature of caries can be described in terms of five interrelated factors. These factors provide guidance as regards prevention and treatment of caries.

FACTOR 1: CARIES IS A BACTERIAL DISEASE

There is abundant evidence that the initiation of caries requires a relatively high proportion of Streptococci mutans within dental plaque. These bacteria adhere well to the tooth surface, produce higher amounts of acid from sugars than other bacterial types, can survive better than other bacteria in an acid environment, and produce extracellular polysaccharides from sucrose. When the proportion of *S. mutans* in plaque is high (in the range 2-10%) a patient is at high risk for caries. When the proportion is low (less than 0.1%) the patient is at low risk. Infection with *S. mutans* usually happens early in childhood by transmission from the mouths of parents or playmates. Because they are more acid tolerant than other bacteria, acid condition within plaque favor the survival and reproduction of mutans streptococci. Two other types of bacteria are also associated with the progression of caries through dentin. These are several species of *Lactobacillus*, and *Actinomyces viscosus*. These bacteria are also highly acidogenic and survive well in acid conditions.

FACTOR 2: CARIES IS DEPENDENT ON DIETARY SUCROSE

Dietary sucrose changes both the thickness and the chemical nature of plaque. Mutans streptococci and some other plaque bacteria use the monosaccharide components (glucose and fructose) and the energy of the disaccharide bond of sucrose to assemble extracellular polysaccharides. These increase the thickness of plaque substantially, and also change the chemical nature of its extracellular space from liquid to gel. The gel limits movement of some ions. Thick gel-plaque allows the development of an acid environment against the tooth surface and allows it to remain unaffected by the beneficial buffering action of saliva. Plaque which has had no contact with sucrose is thinner and better buffered. A diet with a high proportion of sucrose therefore increases the risk of caries. Thicker plaque occurs in pits and fissures and, in patients with poor oral hygiene, near the gingival margin.

FACTOR 3: CARIES IS DRIVEN BY FREQUENCY OF EATING

Each time the plaque bacteria come into contact with food or drink containing simple sugars (monosaccharides such as glucose and fructose, and disaccharides such as

sucrose, lactose and maltose) they use them for their metabolic needs, making organic acids as a metabolic by-product. If these acids are not buffered by saliva they dissolve the surface of the apatite crystals of adjacent tooth structure. This is called demineralization. In thick gel-plaque the pH falls within seconds of contact with dietary sugars, and it can stay low for up to 2 hours. When the pH is neutral the same crystals can re-grow, using calcium, phosphate and fluoride from saliva. This is called remineralization. Caries begins and progresses when demineralization outweighs remineralization. Caries therefore depends on the balance between demineralization and remineralization, i.e. on the frequency of eating (and on the microbial composition of the plaque and its chemical nature and thickness, on the local fluoride concentration and on the buffering capacity of saliva). A frequent pattern of eating therefore increases caries risk.

FACTOR 4: CARIES IS MODIFIED BY FLUORIDE

The mineral of enamel, cementum and dentin is a highly-substituted calcium phosphate salt called apatite. The apatite of newly-formed teeth is rich in carbonate, has relatively little fluoride and is relatively soluble. Cycles of partial demineralization and then remineralization in a fluoride-rich environment creates apatite which has less carbonate, more fluoride and is less soluble. Fluoride-rich, low carbonate apatite can be up to ten times less soluble than apatite low in fluoride and high in carbonate. Topical fluoride also inhibits acid production by plaque bacteria. Fluoride in food and drinks, fluoride in dentifrices and oral rinses and gels, and fluoride in filling materials can therefore all reduce the solubility of teeth, helping to reduce caries risk. These effects are very beneficial, but the amounts of fluoride which can be added to the diet or used topically are limited by safety considerations. High levels of dietary fluoride can cause mottling of tooth enamel during tooth formation, while swallowing even higher levels can cause symptoms of poisoning.

FACTOR 5: CARIES IS MODIFIED BY SALIVA

High flow-rate saliva is a very effective buffer. The balance between demineralization and remineralization can therefore be altered substantially by the rate of salivary flow. Flow is decreased by salivary gland pathology (as occurs in several connective tissue disease and which can follow radiotherapy and cancer chemotherapy), by many mood-altering drugs and some drugs used in other medical treatment, in dehydration and during sleep. Flow increases naturally during vigorous chewing. A maximum salivary flow rate (which can be tested by collecting all saliva while chewing wax or gum) of less than 0.7 ml/min is associated with high caries risk.

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World Health Day 2008: Protecting Health from Climate Change

Health professionals are often called upon to provide necessary services in times of disaster. This is a vast field in itself. In this chapter, general concepts of disaster management will be discussed followed by discussion of natural disasters, chemical disasters and biological disasters. In the end, the existing disaster management system in India will be reviewed. The present account is largely based on the Health Sector Contingency Plan drawn by the Ministry of Health and Family Welfare with WHO support.¹

General Concepts

Definition of Disaster

For operational purposes, the World Health Organization defines a disaster as a sudden ecological phenomenon of sufficient magnitude to require external assistance. Another operational definition says that a disaster is any event that causes destruction and distress resulting in demands that exceed the response capacity of the affected community. Disasters usually have an unforeseen, serious, and immediate affect on health. Often the number of victims is considerable and response to the demand for immediate assistance requires efficient planning and organization of health services.²

A disaster is an occurrence such as hurricane, tornado, storm, flood, high water, wind-driven water, tidal wave, earthquake, drought, blizzard, pestilence, famine, fire, explosion, volcanic eruption, building collapse, transportation wreck, or other situation that causes human suffering or creates human needs that the victims cannot alleviate without assistance.³

Classification of Disasters

Depending on their nature, disasters are classified as:

- Natural disasters, or
- Man-made disasters.

NATURAL DISASTERS

These can be divided into:

- *Tectonic*: Earthquakes, tsunamis, and volcanic eruptions

- *Meteorological*: Hurricanes, droughts, and floods
- *Topological*: Avalanches and landslides.

MAN-MADE DISASTERS

So far, there is no uniform classification for this category. Based on the nature and the effect, these disasters can be divided into:

- Chemical contamination
- Mass intoxication
- Fire
- Mass accidents
- Victims of social violence
- Explosions.

Typical Course of a Disaster

- Temporary shock–population reaction.
- Communication is disrupted.
- Uninvited people streaming to the scene, curious onlookers, media, VIPs.
- Difficulty in obtaining a full picture and making decisions.
- The team gets organized.
- Increased alertness, fatigue, burn-out, and break-down.

Disaster Assessment^{3,4}

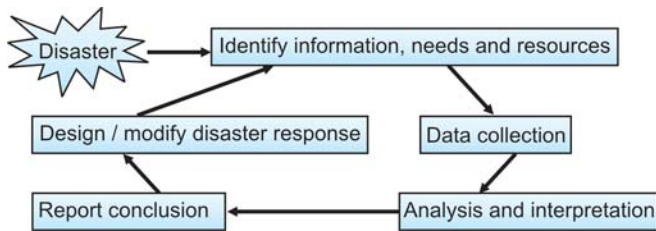
Assessment is a crucial management task which contributes directly to effective decision-making, planning and control of the organized response. Assessment is the process of determining:

- The impact which a hazard has had on a society.
- The needs and priorities for immediate emergency measures to save and sustain the lives of survivors.
- The resources available.
- The possibilities for facilitating and expediting longer-term recovery and development.

Three general priorities are to be identified for early assessments:

1. Location of problem
2. Magnitude of problem
3. Immediate priorities.

The assessment process needs to be continuous and ongoing^{3,4}



Phases in the management of disasters

There are four essential phases in the management of disasters:

1. Warning phase
2. Emergency phase
3. Rehabilitation phase
4. Recovery phase.

Some General Guidelines are followed⁵⁻⁷

Camps for temporary shelter for the displaced are organized optimally so that there is equity in distribution of resources and disease and disability are minimized.

- At first support of the local administrative officers are enlisted like Gram Panchayat, NGO, Self-help Group, Community Leaders, etc.
- A registry is maintained in the camp with an identification number given to each person, which facilitates proper distribution of relief aid and health care. As far as possible, accommodation of the persons in the camp is done as family units.
- Lay out of the camp need to be well planned like separate allotted area for specific purposes, like sleeping, cooking, storing (water, food, clothes, consumables), latrines and sewage disposal. Training

is done in the camp/community with the group leaders. During organizing a camp, four specific areas are given priority, i.e. (a) Water supply, (b) Nutrition and food hygiene, (c) Sanitary facilities, and (d) Proper garbage disposal.

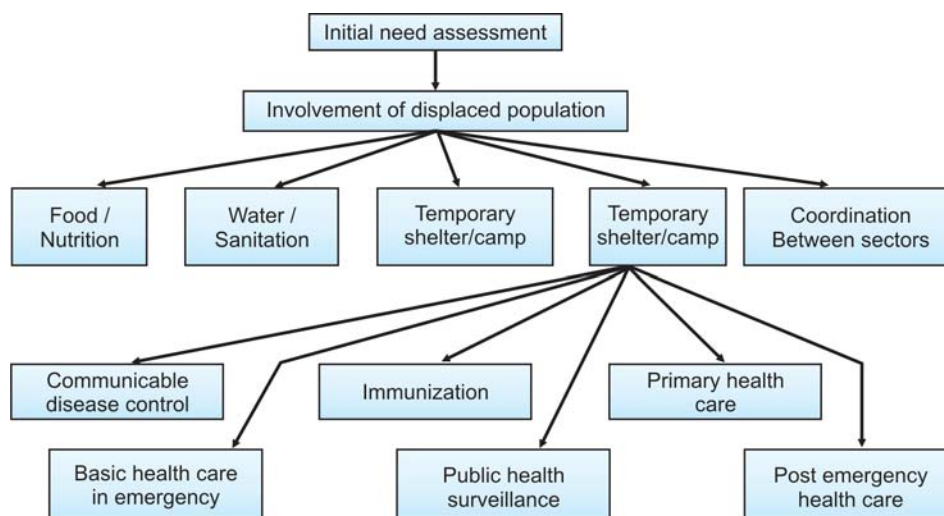
Water Supply

- Water source is identified at first (e.g. wells, water barrels/ tanks, pipe borne water).
- Safe and potable drinking water is ensured, by training the leader in water sanitation (chlorination, boiling and storage of water, health education, supervision). In the community/camp a place is arranged to boil water.
- Water is stored in three separate containers for drinking, cooking and washing (bathing and toilet) purposes. Use of a filter is best if available. Pail with a long handle is used to take water from the container. Soap must be there for hand washing.

Nutrition and Food Hygiene

- A team of food handlers are appointed. They are being educated for personal hygiene, and food (storage of cooked food) and water sanitation. They are also being provided for food safety (cooking utensils, food covers).
- Breastfeeding is important during emergencies to ensure the essential nutrition and prevention of communicable diseases. In this type of situation especially infants and children are more prone to infectious diseases (due to poor sanitation and depressed immunological status) therefore feeding with breast milk is very important. Distribution of artificial milk and bottles in camps are strongly discouraged, where mothers are available. In situations where artificial feeding is

The initial assessment should be followed up with more detailed assessment during the rehabilitation and recovery phase as shown in the following flow diagram³⁻⁵



done, feeding is done by cup rather than a bottle because it is easy to clean/sterilize and the risk of infection is low.

Sanitary facilities: Adequacy and cleanliness of toilets are ensured. If inadequate, trench latrines are constructed in a suitable place away from the cooking site. Proper disposal of stools are ensured.

Proper garbage disposal

- Garbage are collected, sorted and disposed off in a suitable place.
- Flies are controlled by wet mopping of all surfaces (floors, furniture) with cleaning solution and insecticide spraying.
- Cleanliness in and around the camp is maintained by health education and supervision.
- Many people with chronic diseases have lost their drugs and records, and do not have access to clinics. These areas need special attention.
- Injuries are among the commonest health problems immediately after a natural disaster.
- The psychological impact of trauma on children is more severe than in adults, but children are unable to express their negative thoughts. Policy planners must play an active role to relieve the psychological impact on the community.
- Infections are common in overcrowded camps: dysentery, acute gastroenteritis, upper respiratory tract infections, vector borne infections (especially dengue and malaria), exanthemata (especially chickenpox), scabies, ringworm and head lice, etc.
- Deaths due to disaster often require medico-legal investigation, especially for identification.

Medical Care at the Disaster Site

Experience has shown that there is usually much confusion and disorganization in handling victims at a disaster site. The convergence of numerous relief agencies tends to cause competition and results in ineffective action. Frequently observed problems include insufficient organization and stabilization of patients, inadequate training for providing timely medical care, inappropriate distribution of patients to hospitals, deficiencies in communication coordination, and an absence of a person in authority and command.

Potential Risks at the Disaster Site

Health staff (physicians, paramedics, and rescue squads) can potentially be at risk for accidents at the scene of the disaster, owing to toxic gas leaks, asphyxiation by smoke, secondary fires, explosions, collapses, electric discharges, and others. Although these risks are not common to all disasters, personnel must be adequately prepared for safety measures. Carelessness could lead to a secondary disaster. It is also important to point out that personnel at the disaster site work under high

emotional and physical pressure, and in conditions and environments, that they might not be familiar with.

Management Aspects

COMMAND POST

The purpose of a command post is to coordinate activities at the disaster site. Lack of organization coupled with the presence of various rescue squads and relief groups that rush to the disaster site (the fire department, the police, Red Cross brigades, mobile hospital units, emergency medical services, and volunteers) cause chaos. In order to avoid this, a single authority for operations must be established to coordinate activities at the disaster site, including health actions. This role is usually assigned to a ranking officer of the police or fire department.

FUNCTION OF THE COMMAND POST

The essential functions of a command post are to provide a preliminary evaluation of the magnitude of the disaster, coordinate emergency medical care, delimit the affected area, establish safety measures and a network of emergency communications, regulate traffic, and set up a public information post for the press. The relief agencies or brigades working at the disaster area should assign a representative to the command post. All staff assigned to the command post should wear a badge to identify themselves clearly.

MEDICAL COORDINATOR AT THE COMMAND POST

A physician with experience in mass casualty management should be responsible for coordinating health activities at the disaster site. In the absence of a physician, a qualified nurse or paramedic with broad experience could be assigned to this position.

An organized community that has a plan for disaster situations predesignates a medical authority to this role. The medical coordinator, as part of the command post, is responsible for organizing and coordinating emergency medical care and for mobilizing and transporting victims from the disaster site to hospitals. This coordinator should be a professional with sufficient authority over the medical and paramedical personnel to assign tasks and areas of action. The medical coordinator works closely with the physician responsible for classifying the patients by degree of urgency and with the assistant responsible for transportation.

TRIAGE

The word triage is of French origin and means selection or categorization. The concept of triage in a disaster situation means classifying victims in order to assign priorities for medical care and transportation.

Triage Activities

This concept is based on establishing the urgency of a case and the victim's likelihood of survival. It differs from daily emergencies where the most serious cases always receive priority care, without consideration for the likelihood of survival. Triage actions at the disaster site include identifying victims, assessing injuries, assigning priorities for care, and stabilizing and transporting victims to centers for further care.

Tagging

Without a method to identify victims according to their assigned priority for medical care, triage would not be a viable concept and handling a great number of victims would be confusing and laborious. Several tagging methods have been used, such as: marking the victim's skin in a visible place; applying piece of adhesive tape to the victim's forehead to indicate priority; or, using color codes. The purpose of standardized tagging system is to provide an easily-visible label that identifies the patient and indicates the nature of the injury and the priority assigned for treatment and transportation. The most popular method is triage cards.

Color Codes for Priorities

As a matter of convenience, most emergency medical services use red, yellow, green, and black to identify priorities for care and to mobilize disaster victims. This does not mean that other standardized models cannot be used.

Stages of Triage

Triage is an ongoing process that begins at the disaster site and continues until the patient enters the hospital to receive further treatment. The victim's survival depends on the effectiveness and timeliness of this activity.

Rescuing Victims

Rescuing victims is often a very complex task, especially if they are trapped or under rubble in difficult to reach places, or when they are exposed to secondary risks, such as fires or toxic substance leaks. Usually, complex rescue tasks are not within the scope of health teams. Specialized equipment and specific training was needed to rescue some victims in the aftermath of the earthquakes in Mexico, El Salvador and the volcanic eruption in Colombia.

Triage Area and Collection Centers

Depending on the magnitude of the disaster and the number of victims, one or several, "victim collection center" or "triage areas" are indicated at the disaster site. A triage area is the area where victims are placed immediately after rescue and where they undergo a physical examination in order to assign priority for

treatment and transportation to hospitals. Emergency medical care at these areas is aimed at stabilizing the patient and providing basic care to ensure survival. Usually, stabilization implies clearing the respiratory tract, controlling bleeding, and maintaining circulation. The triage area should be the responsibility of a physician or, alternatively, a nurse or paramedic with experience in mass casualty management and with authority to coordinate emergency care activities at the disaster site. The triage officer has an important role. After a rapid medical examination, he assesses the victims and assigns them the respective priority.

MOBILIZATION AREAS

After triage, the victims are placed in areas designated for each priority. The areas should be easily identified by flags or other means using colors that correspond to each priority.

In these areas, the victims are organized in lines until they are transported according to their assigned priority. At this stage, personnel should take emergency actions to stabilize the patient, prepare him for transportation, complete identification data, or suggest a I priority modification in accordance with the evaluation of the patient. This is also the area where fractures are set.

MOBILE UNITS

Depending on the nature of the disaster, damage to physical structures, distances, I and the super-saturation of existing services, the use of mobile units to provide emergency medical care at the disaster site can be justified. These support units can function as first aid or rapid treatment centers. Mobile units are costly and their use should depend on the performance and self-reliance of the personnel, equipment and supplies.

MEDICAL EQUIPMENT AND SUPPLIES

Medical care at the disaster site requires a sufficient quantity of medical supplies to meet the needs of the emergency. Essential supplies should be duly classified and distributed in clearly identified and easy-to-transport boxes. The boxes should contain the following basic supplies and equipment:

- Triage cards and writing material
- Basic equipment for ventilation and portable cylinders of oxygen.
- Treatment material, including bandages and antiseptic solutions.
- Medical satchels with basic instruments and emergency drugs.
- Basic instruments for minor surgery and splints.
- Intravenous solutions, perfusion equipment, and disposable syringes and needles.
- Portable lighting equipment, including flashlights.
- Basic tools.
- Clothes, blankets, and sheets.

Natural Disasters

A detailed account of planning for natural disasters has been given in the WHO document planning for natural disaster.⁸ Earlier, focus of attention of Crisis Management was confined to natural disasters, that too on relief activities. After Bhopal Gas Tragedy in 1984 and Chernobyl accident in the mid 80s, list of crisis situations has broadened which now include industrial, nuclear as well as biological disasters.

The achievements in the health sector as regards disaster management can be noted by the fact that the contingency plan to meet natural calamities is available up to Block Level. As a result the Health Sector could effectively meet health needs of the affected population during two devastating natural disasters—Cyclones in Andhra Pradesh in 1990 and earthquake in Maharashtra in 1993. However, the health sector faced a lot of criticism during recent outbreak of Plague as well as during the earthquake in Uttarkashi in 1992. It clearly shows that preparedness activities are not uniformly followed throughout the country.⁹

Guiding Principles for Health Sector Flood Management

Natural calamities like flood are regular phenomena in India. Some parts of the country are more prone than others. With scientific development, flood forecasting is made much in advance. Public health measures can be well planned in advance in a systematic and scientific manner.

PUBLIC HEALTH RISKS

The health problems relating to flood can be either due to direct impact on human population, direct impact on existing infrastructure and resultant effects due to combination of these factors.

- Direct impact: Resulting in drowning
- Damage to existing infrastructure
 - Direct effect on water, power supply and sanitation facilities, forcing the community to consume polluted water and stay in unsanitary condition.
 - Damage to existing health infrastructure resulting in ineffective functioning of available facilities.
 - Destruction of houses: The affected population is exposed to adverse climatic conditions leading to disease particularly respiratory, infection, and fever.
 - Damage ration shops and other shops providing food may lead to storage of food in affected community leading to starvation conditions.
- Combination of factors: The above factors may change the living conditions of the community temporarily till they are finally rehabilitated. Sudden change in environment leads to following factors, each contributing to health problems.

- Population displacement: There are two ways by which population displacement may effect the health of the affected community:
 - i. Movement of population results in overcrowding at new places with possibility of transmission of diseases from moving population to local population of new places.
 - ii. Health problems in temporary shelter: When the affected community is shifted temporarily to a new place, existing water supply system, toilet, cooking space becomes inadequate leading to unsanitary conditions resulting in different types of diseases, specially, diarrheal diseases. Epidemic may be a possibility.
- Population density: Density of population increases proximity, resulting in spread of diseases.
- Work pressure on existing health infrastructure: The existing health centers may suddenly start getting large number of patients which may suddenly start getting large number of patients which may be more than their absorbing capacity. Additionally, if these centers are also affected by floods, it may be difficult for them to discharge their responsibility.
- Psychological manifestation: Loss of property or loss of lives of relatives produces tremendous tension and pressure on mind resulting in anxiety, neurosis ore depressions. Due to such psychological manifestation, the affected persons remain unhappy despite any amount of gratuitous relief, which are commonly seen during such situations.

LIST OF COMMON AILMENTS/DISEASES FOUND AFTER FLOODS

- Respiratory diseases [Due to adverse condition of living]
- Injuries (not very common—Due to collapse of houses/standing structure)
- Water-borne diseases/Diarrheal diseases [Due to nonavailability/Inadequate availability of drinking water]—Cholera, gastroenteritis, dysentery, infective hepatitis, poliomyelitis.
- Malaria/Filaria due to increase in mosquito breeding space
- Skin diseases/Eye diseases/Respiratory diseases—Due to lack of personal hygiene and overcrowding
- Snake/Insects bites—Due to water entering into the shelters of biting creatures.

FLOODS—DO'S AND DON'TS¹⁰

- Always keep your safety kit with medicines, identify papers, dry food, torch, etc. ready during flood season.

- Leave for safe (higher) place in time.
- Drink only boiled or chlorinated water.
- Beware of problem of cholera and take precautions.
- Untie domestic pets (cattle, hen, etc.) before leaving the house.

SPECIFIC PUBLIC HEALTH ACTIVITIES FOR FLOOD

Water-borne diseases are one of the most common phenomena during flood. Diarrheal diseases are only the earlier manifestations but diseases like typhoid, infective hepatitis and poliomyelitis are usually seen after about a fortnight. Therefore, emphasis, as far as preventive measures are concerned, is given to consumption of safe drinking water, other hygiene and sanitation measures and public education.

- **Safe drinking water:** Safety of drinking water can be ensured whether at the point of storage or distribution. Various methods practiced are:
 - **Boiled water:** Water could be boiled for 10 to 15 minutes and then stored in clear and covered containers.
 - **Use of chlorine tablets:** Nascent chlorine makes water safe for drinking. The tablets may be of the following types:²
 - Weight 2.5 gm [Contains 300 mg chlorine, sufficient for 225 liters water]
 - Weight 0.5 gm [Contains 25 mg chlorine, sufficient for 20 liters water]
 - Weight 0.125 gm. [Contains 1.25 mg chlorine, sufficient for 1 liter water]
 - **Bleaching powder:** Bleaching powder is used to disinfect usually bigger sources of water. Usual dose (with 35% chlorine) is 2 gm for 5 liters of water. In case of wells, appropriate calculation needs to be done as explained in the chapter on water. At least 0.245 ppm of chlorine should be available in water for safe drinking.²
- **Other hygiene and sanitation measures:** These include the following:
 - **Disposal of water and excreta:** Existing infrastructure is likely to become ineffective. Therefore, adequate arrangements for disposal of wastes should be planned in advance, so that it can be executed immediately.
 - **Fly proofing:** Areas including houses/shelters should be disinfected regularly by spray of bleaching powder.
- **Health education:** This includes use of mass media like radio, newspaper, pamphlets, leaflets containing small repeated message on the following points:
 - Personal hygiene
 - Water consumption
 - Use of boiled water and chlorine tablets
 - Food hygiene.

Guiding Principles for Health Sector Drought Management

Drought, whatever the cause, has continued unabated to ravage many nations in the world. In India, the midtwentieth century Bengal famine, which caused widespread deaths, was largely a man-made famine. Currently, large famines in India seem to be a thing of the past. The last famine in many states in India was in the year 1987, but it was reasonably well managed.

Drought is a protracted emergency which invariably leads to shortage of food. The problem gets multiplied if poverty illiteracy and backwardness are also associated. The impact is thus most in the sphere of nutrition in general and especially among children lactating and pregnant mothers.

The estimated population of children in the age group below 5 years would be 17 percent and that of lactating and pregnant mothers will be 3.5 percent or in other words, 20 percent of the population will need special care immediately. It has also been noted that in the drought affected areas infant mortality is very high and incidence of water-borne diseases like diarrhea and dysentery are also very high. There is special risk of vitamin A deficiency.

CONTINGENCY PLAN FOR MEDICAL CARE DURING DROUGHT

- A cell should be established under the charge of a senior officer in the Directorate of Health Services to exclusively monitor a view the public health measures for the drought affected areas in the State.
- The epidemiological cell of the Directorate of Health Services should be alerted and asked to keep itself ready to meet any eventuality if any epidemic disease breaks out. The unit should also be asked to take anticipatory preventive measures in the form of obtaining information in respect of epidemic prone disease, immunization of preventable diseases, etc.
- Emergency drug, vaccines, etc. should be procured and kept ready.
- Children below 5 years, expectant and nursing mothers are the special victims of drought. Every effort should be made to reach these population groups on a priority basis. In the entire drought affected area they will be around 20 to 30 percent of the total population. In addition, the aged, the infirm, the disabled and the destitute will pose special problems during drought. The health officials should be instructed to look after these categories of people.
- During drought, diseases like gastroenteritis, dehydration, pneumonia, cholera, typhoid, dysentery, measles, parasitic diseases and other including nutritional disorders will pose special

problems. While working out the requirement for the drugs and vaccines, diseases listed above need to be kept in view. Adequate provision for antibiotics, ORS, vitamins and other essential drugs need to be made.

- All drinking water sources need to be identified and every effort made to disinfect the same with chlorine or bleaching powder. It is preferable if it is done daily during the drought period to prevent onset of epidemic. However, depending upon the resources and the nature of water sources, this could be done two or three times a week under certain circumstances.
- Evaporation leads to loss of around 30 percent of water in big reservoirs supply water. Antieaporating agents like Centyl alcohol are often used to prevent such water loss/direct evaporation.

Biological Disasters

A detailed account of planning for biological disasters has been given in the WHO document Planning For Biological Disaster.⁹

Guiding Principles for Planning

BIOLOGICAL DISASTER AND EPIDEMIC

Biological disaster is one of the technological disasters caused by microorganisms leading to spread of diseases by pathogenic organisms or toxins. With the advancement in technology of genetic engineering, possibilities of release of causative agents in the environment may create a crisis situation which may not be possible to be handled by the affected population. Such possibilities could be accidental or otherwise.

MICROORGANISMS PRODUCING CRISIS SITUATION

Microorganisms causing war-fare or disaster could be Bacteria, Viruses or Toxins produced by plants, animals and bacteria. The respective lists of known pathogens and toxins which could create biological disaster have been given in the WHO document.⁹

SOURCES

Contamination with these pathogenic organisms can start from human or animal sources. Bio-toxins causing a disaster can, in turn, arise from microbial, plant or animal sources. All pathogenic agents of biological origin are capable of multiplication in the environment, and, eventually, may affect man through food chain, water source or direct exposure. They may even affect the population through fish and crabs. For example, human

casualties due to pesticide poisoning occurred a few years ago in coastal Karnataka through crabs affected by pesticides from neighboring fields.⁹ Food items, in addition, could also be affected during food processing and storage.

Microorganisms are also handled widely in medical, agricultural, veterinary fields and research laboratories. They are also used for preparation of enzymes, sera and reagents which have commercial values and handled exclusively by commercial manufacturers. Any contingency plan would, therefore, remain incomplete unless all such organization/institutions where they are handled are also brought into its purview.

INTRODUCTION OF NEW FORM OF ENDEMIC DISEASES

New and resistant forms of diseases may emerge as a result of genetic mutation in organisms and these may lead to disaster situation like malaria and polio resistant to usual preventive or curative measures.⁹

SPREAD OF DISEASES FROM ENDEMIC TO NONENDEMIC REGION OF THE COUNTRY

Transmission of endemic diseases prevalent in one part of the country to nonendemic one, may create a crisis situation in the country. For example, introduction of *Shigella dysenteriae* from West Bengal or Assam causing bacillary dysentery in Punjab.

New Diseases

This situation may arise during war or by accidents in laboratory, etc. A capsule full of toxins or organisms left over in a part of the country may create crisis situation. There may be following scenario:

- *Introduction of new diseases unknown to the country:* Epidemic of yellow fever in Asian countries from African subcontinent.
- *Introduction of new diseases as a result of DNA recombinant technology:* DNA recombinant technology may, produce a new type of organism entirely different than the original and, therefore, uncontrollable by routine preventive measures leading to epidemic situation. This technique may also be used in war.
- *Leakage of new viruses from experimental laboratories:* It may be necessary to identify such laboratories, conducting special experiments, etc.

Special Considerations for Bio-toxins

As far as biotoxins are concerned they are slow to manifest. On the other hand, manifestations may not be uniform in symptoms, time and place of occurrence. One of the important considerations in dealing with

biological disasters as a result of toxins is that a toxin can be easily implanted in large population through water and food. Therefore, it may be necessary to have sufficient checks at the concerned places. Such places should particularly include the following:

- Food processing plants
- Storage warehouses
- Potable water and reservoirs
- Research laboratories
- Agricultural areas.

Emergency Immunization

Immunization to those at risk should be planned, well in advance because it takes at least 7 days to develop some immunization. In an emergency, method for mass immunization is different. In some disease passive immunization or medical treatment may also be effective.

STRATEGY FOR IMMUNIZATION

Target: Seroepidemiological investigation would give a correct picture about group of people to be immunized. In some cases children may be the target group.

PRIORITY OF IMMUNIZATION

Whether immunization should start from center to periphery and vice versa or in peripheral area, would be clearly indicated by positivity of seroepidemiology. Detailed indications for immunizations have been provided by WHO.⁹ In case of different preparations are available, choice will depend on cost, mode of delivery (oral, injection) and the stability.

Time schedule for completion of immunization program

Aim should be to complete as soon as possible.

Indications for Passive Immunization in Emergencies

The diseases for which immunization needs to be considered in biological disaster situations are listed below. The Type of Immune preparation to be used is shown in parentheses. Details can be seen in the original document.⁹

BOTULISM

[Trivalent botulinal antitoxin (types A, B and E), or the specific antitoxin required].

NB: Before administration, check for sensitization to horse serum.

DIPHTHERIA

[Antitoxin]

NB: Before administration, check for hypersensitivity.

PERTUSSIS

[Human immune globulin, special pertussis hyper immune globulin]

NB: Value not proven.

RABIES

[Rabies immune globulin, injected locally and intramuscularly]

NB: Must be complemented by vaccination; check for sensitization if immune globulin of animal origin is used.

TETANUS

[Equine or bovine tetanus antitoxin or human immune globulin (special preparation for intravenous administration)]

NB: Check for sensitization to animal serum; start active immunization with adsorbed toxoid and administer antibiotics.

VARICELLA

[Human varicella zoster immune globulin]

NB: Give within 3 to 4 days of exposure; limited supplies, restricted to special medical indications.

VIRAL

Hemorrhagic fevers (Lassa, Ebola, Marburg, Junin and Machupo) and tick-borne encephalitis—[Immune plasma from convalescents]

NB: Limited quantities (available through WHO); efficacy still doubtful (it should preferably be administered in the first 4 days).

VIRAL HEPATITIS A

[Human immune globulin with a specific titer of at least 100 IU. Should be given to household contacts within 2 weeks of exposures and to travellers at risk].

VIRAL HEPATITIS B

[Human hepatitis B immune globulin].

BIOLOGICAL WEAPONS/TYPES

Microorganisms causing war-fare or disaster could be Bacteria, Viruses or Toxins produced by plants, animals and bacteria. These may be known or unknown.

Known Pathogens/Toxins

A detailed list of known pathogens and toxins which could create biological disasters has been provided by the WHO.⁹ There are certain bacteria about which well documented information against effective measures is available. Some of these are Anthrax, Tularemia, Plague and Botulism.

New Pathogens/Toxins

Information about the pathogenicity of these bacteria is not known outside the laboratories manufacturing them. Release of causative agents with new characteristics in the environment can obviously pose challenging problems.

Chemical Disasters

Introductory

The chemical industry is prone to serious hazards as unfortunately exemplified by the Bhopal disaster. Therefore, a hazard assessment system for the chemical industry has to be activated at an early date.¹¹

Plans for prevention of chemical disasters cannot be divorced from an overall strategy for facing disasters whether they are due to human error or due to technological development. Technological disasters, particularly those involving toxic chemicals require, in addition, institution of an immediate emergency plan of antidotal treatment of the victims, cleaning the environment affected by the toxic chemical and a long-term health surveillance of the population exposed to the toxic chemical. Chemical Disaster Management also includes appropriate legislation for control of toxic chemicals.

Natural vs Chemical Disaster

Globally accumulated experience of natural disasters such as earthquakes, floods, cyclones, etc. can be used for future preparedness for emergencies such as the outbreak of epidemics, the psychiatric trauma of loss of shelter and security or contamination of food and water. In contrast, the consequences of chemical disasters and their impact on environmental health are almost unpredictable. There is usually no warning signal and hence very little time to prepare the community to brave the consequences. More often than not, the cause effect relationship in a chemical disaster is difficult to establish and hence the initiation of measures for emergency treatment has to be done on arbitrary considerations. This can have an adverse influence on the post emergency rehabilitation scheme as well.

The decade 1974 to 84 witnessed an usually large number of industrial accidents involving hazardous chemicals: The Flixborough explosion, the Beek disaster consequent on the release under pressure of propylene, the Seveso disaster, the Mississagua accident due to collision of wagons of chlorine and propane, the Houston spill of anhydrous ammonia, the Sommerville, Massachusetts spill of phosphorous trichloride, the Mexico explosion involving liquefied gas and , the worst of all, the Bhopal Disaster of Dec. 1984.

The scenario of the above accidents differed from event to event. The tragic sequel also varied in magnitude and impact on life systems. However, all the above incidents fulfilled the criteria of definition of a disaster given by WHO, viz. “a situation of unforeseen, serious and immediate threat to public health” or that given by NATO viz. “an act of nature or an act of man which is or threatens to be of sufficient severity and magnitude to warrant emergency assistance.”

The Disastrous Event

Most of the existing knowledge on chemical disasters deals primarily with the mechanics of the event. Scenarios can be constructed on a miniscale to explore the dynamics of diffusion of toxic clouds. Computer simulation can help in detecting of defects in design. The hazard potential of chemicals receives special consideration in reference to their production; storage; transport; designing the concerned equipment and operating the same routinely. Containers meant for captive storage of hazardous chemicals, equipment for their transfer to reaction vessels and to transport them by rail, road or ship to distant places have all to be designed and constructed using knowledge of their special properties and the ability of construction materials to withstand the impact of high temperature and pressure of vacuum.

Consequences of the Disastrous Event

The following situations may occur:

- Leakage of corrosive fluid from a tank and spill to water bodies, cultivated land, violent explosion, fire ball formation, etc.
- Leakage of highly toxic cloud of gaseous and particulate material which spreads to neighboring habitations.

In both types of disasters mentioned above, life system in the vicinity of the site are ready targets. In contrast the likelihood of installations and buildings becoming targets is more in the first type of disaster. As regards life systems, the harmful effects may be manifest even at places quite distant from the site of disaster because of the discharge of toxic chemicals into any one of the three main compartments of environments: air, water and soil. Polluted air and water can contaminate food crops and food animals, poultry, dairy cattle and fish, etc. and thus produce insidious but perceptible effects on human health.

Identification of the targets has to be done immediately. This requires expertise and trained personnel. Since both life and property are potential targets, background information on the site of disaster, nearby habitations and the environment is essential. Once the nature of the disaster and the targets are identified, it becomes relatively easy to assess its effects.

Health Effects of Massive Chemical Exposures

The effects produced by a chemical disaster would primarily depend upon the nature of accident and vary from target to target. The effects on life systems can be lethal if a toxic gas pollutes the air. When the source of drinking water is contaminated, delayed effects will manifest themselves. The possible biological effects likely to accrue from chemical depend upon the extent of exposure and the potential of the implicated chemical to interact with diverse anatomical structures and physiological functions. Adverse effects could be instantaneous death or the appearance of disease clusters. Individual susceptibility, degree and duration of exposures and failure or success to counter immediate effects modify prognosis.

Risk of cancer and mutagenic changes in the progeny are to be anticipated. Contamination of ambient air is presumably the most significant pathway by which the toxic chemical attacks the target organ in major chemical disasters. Intake by inhalation or absorption through skin and mucous membrane constitute the main routes of entry. In the case of contaminated water or food, the targets will be the digestive and assimilative systems.

Assessment of Risk

A large number of chemicals are known to be highly toxic to man. Many of them are alien to the human system and the external environment. They are capable of disturbing economical equilibrium and hence impair the survival of life-support systems. What is the basis on which the risk of exposure to these chemicals is assessed?

Risk management of toxic chemicals comprises the following steps:

- Identification of the hazard
- Estimation of the hazard
- Assessment of the risk to the community
- Availability of safer alternatives
- Assessment of the ability of the community to absorb “acceptable” risk
- Safety evaluation of chemicals.

The safety evaluation of chemicals has two important interlinked components:

1. Exposure assessment making estimates of the chemical in the environment and in the target organisms.
2. *Toxicity evaluation*: This is an area where lot of work needs to be done. A study conducted by the prestigious National Academy of Sciences revealed that more than 70 percent of the chemicals in use in commerce in USA are yet to undergo rigorous toxicity evaluation as required under regulatory procedures.¹¹

Preparedness Plan for Meeting Chemical Disasters

Such a plan should cover different phases before the disaster and after the disaster:

IDENTIFICATION OF THE HAZARD

All existing and potential hazards in chemical industry must be identified and inventorized. After notification, an appropriately constituted inspectorate system should check the hazards periodically.

RISK ASSESSMENT

It is essential that the exact location of the hazardous installation is demarcated along with its surrounding ecosystems. Assessment of impact on human population, natural vegetation, cultivated lands, cultural property and fragile ecosystems of possible massive leakage of chemicals from the site should be made periodically. The risk involved must be balanced against societal benefits.

ON SITE AND OFF SITE PREPAREDNESS PROGRAM

Next to hazard identification and risk assessment the urgent task to be accomplished is the setting up of an effectively orchestrated on site and off site preparedness program. An ideal system for chemical disaster management should consist of:

- An authority to give directives based on updated information with a back-up of research.
- An alert system which not only gives the warning but also establishes an effective communication network.
- A local authority to carry out the directives for migration of the injured and for instituting measures for relief and rehabilitation.
- *Communication/Alert system*: In addition to well known essential components of natural disaster management plan, chemical disaster plans have to include an efficient communication mechanism which triggers the activation of emergency treatment units where the human victims and affected animals are given appropriate chemical antidotes to flush out toxins from their bodies.
- *Off site emergency*: Off site emergency plans have to deal with identification of vulnerable Groups; their prompt evacuation if a recurrence of release of toxic material is anticipated; mopping up of water and food sources; and decontamination procedures for exposed land and vegetation. Furthermore programs have to be initiated for rehabilitation of victims.

FIRE—DO'S AND DON'TS¹⁰

- Switch off gas supply from cylinder and electrical appliances when not in use.

- Keep clothes, curtains and other potentially combustible items at least 3 feet from room heaters.
- Keep a fire extinguisher in home or office and learn how to use it.
- Not to overload electrical extension cords.
- Call fire brigade urgently when fire is noticed.
- Do not allow children to play with matchboxes or lighters and electrical appliances like room heater, immersion heater, iron, hair dryers, etc.

Natural Disaster Management in India

India with a wide range of climatic and topographical conditions is subject to various types of natural disasters. In contrast, biological and chemical disasters take only a second place. The extent and severity of natural disasters in India is briefly indicated below:

Floods

Flood is a common natural disaster during the later part of the monsoon period. Floods are estimated to affect 6.7 million hectares of land annually. The statistics of 10 years (1979-89) indicates that on an average in India about 30 million people are affected every year.

Drought

Drought is also perennial feature in India. Sixteen percent of the country consists of drought prone areas. Statistics of 10 years (1979-89) show that on an average more than 50 million people are affected annually by the drought conditions.

Cyclones

The coastal area of the country experiences about two to three tropical cyclones of different intensity every year with varying degree of destruction and loss of life. East coast is more vulnerable than the west coast. Statistics of 9 years period indicates that on an average at least 3 cyclones of varying intensity touch the Indian coast every year.

CYCLONES—DO'S AND DON'TS¹⁰

- Keep monitoring the warnings. This will help to prepare for cyclone emergency.
- Switch off electrical mains in the house.
- Keep some dry nonperishable food and medicines always ready for emergency use.
- Check the house, secure loose tiles, carry repair works for doors and windows.
- Fishermen should not go for fishing in high seas after cyclone warning.
- Have to evacuate the place during emergency.

Earthquakes

The Himalayan region from Kashmir to Arunachal Pradesh is in the seismic Belt. Twenty earthquakes of severe magnitude affected India during the last century. The recent earthquake in Latur and Osmanabad districts of Maharashtra indicated that a large number of casualties can take place even in a low seismic zone.

EARTHQUAKES—DO'S AND DON'TS¹⁰

- Follow BIS codes relevant to concerned area for building standards.
- Repair deep plaster cracks in ceilings and foundations. Expert advice should be sought if there are signs of structural defects.
- Do not stay close to glass, windows, outside doors and walls and anything that could fall such as lighting fixtures or furnitures.
- Do not use elevators during earthquake.
- Ascertain the exit plan from the building.
- Switch off electrical gadgets and power supply.
- Know emergency telephone numbers (doctors, hospital, police, etc.).

Statewise Analysis

By and large in India, all States/Union Territories are likely to face a disaster situation like drought, flood, cyclone and earthquake. Based on information from the Ministry of Agriculture (Deptt. of Natural Disaster Mitigation), there are 21 States/UTs. Which are most vulnerable? Out of 21 State/UTs, 1 State faces all 4 types of disasters, 4 States face 3 types of disasters, 11 face two types of disasters and 5 face one type of disasters. All 5 States, which are prone to only one type of disaster, face severe drought situation every year.¹

National Policy

In a federal set-up, as in India, the responsibility to formulate the government's response to a natural calamity is essentially that of the concerned State Government. However, the central government supplements, to the extent possible, the efforts of the state government by way of providing financial and material assistance for effective management of the situation in accordance with the existing scheme of financing the relief expenditure.

The present scheme of financing the relief expenditure arising out of natural calamities has come into force with effect from April, 1990 consequent upon the acceptance of the recommendations of the Ninth Finance Commission. Under this scheme, a calamity relief fund (CRF) has been constituted for

each state with certain amount allocated to them. Of this amount, 75 percent is contributed by the central government and given to the state in four equal installments. The balance 25 percent is provided by the state government from its own resources. Following the constitution of the CRF, it is the responsibility of the concerned state government to meet the expenditure on calamity relief. However, in a crisis of a severity, the government of India will examine the case and, if found deserving, give additional funds to the state through a newly created corpus fund called National Fund for Calamity Relief (NFCR).

Disaster Management Structure in India

State Level

As mentioned earlier, under the Indian Federal System, disaster management is the responsibility of state government. Research, surveys, guidelines and provision of financial assistance to the states are provided by the central government. Details of state structure, which varies from state to state, will not be presented here, though general role of the state machinery in disaster management will be touched upon while describing the national aspects.

National Level

At the central level, there is a Crisis Management Group headed by the Cabinet Secretary and consisting of nodal ministries in charge of different types of disasters and support ministries consisting of concerned department/ministries. For Natural Disasters, Ministry of Agriculture is the Nodal Ministry, other Ministries are supportive departments. In the event of disaster, a multidisciplinary central govt. team, at the initiation of the affected state, conducts a disaster assessment and also makes recommendations for assistance.

Responsibility of disaster preparedness and response in the state is usually discharged by the Relief and Rehabilitation Department of the department of revenue. The Crisis Management Group at the state level is headed by the Chief Secretary of the Government with participation of all the related agencies.

At district level, a District Level Coordination and Review Committee is constituted and headed by the Collector as Chairman in which all other related agencies and departments participate.

Role of the Health Sector

PUBLIC HEALTH IMPACT FOLLOWING DISASTERS

Flood, cyclone and drought are common disasters seen in India. Water-borne diseases like diarrhea, dysentery and typhoid are widely prevalent and get exacerbated during these disasters. Cases of malaria and filarial also increase after 10 to 15 days of monsoon or after flooding. Leptospirosis has been found in a few areas in Tamil Nadu. Bacillary dysentery caused by *Shigella* has been found in West Bengal and Assam adjoining Bangladesh.

Earthquake impact on water supply and sanitation and make the affected population vulnerable to diseases like diarrhea, dysentery and acute respiratory infections. One of the responsibilities of the Health Department during this period is to provide immediate medical care and keep their surveillance mechanisms specifically alert.

Disaster Management Structure in Health Sector

National Level

The Emergency Medical Relief Division of Directorate General Health Services in the Ministry of Health and Family Welfare is the technical unit exclusively meant for management of crisis situations. The Division is headed by Director, Emergency Medical Services and Relief. For the purpose of the crisis situations, he reports/receives instructions directly from the technical chief (Director General of Health Services) and the Administrative Head of the Ministry (Secretary Health and FW). The secretary, Health and FW has empowered Director, EMR to represent the Dept. for crisis situation in different Crisis Management Groups.

Disaster Management requires multisectoral and multidisciplinary approach, which needs coordination at various levels from Central to District Level. In the Ministry of Health and Family Welfare (Govt. of India) such mechanism of coordination is done through the office of the Director, Emergency Medical Services and Relief (EMR). The objective of the coordination is to review crisis situations from time to time and meet those needs, which state government cannot meet. For this purpose, continuous dialogue and communication are maintained with the Directors of Health Services, Stores Division under the Federal Government, vaccine producing institutes, National Institute of Communicable Diseases and Director, Malaria unit.

State Level

Usually a Joint Director or a Deputy Director of Health Services under Director of Health Services in the state is responsible for crisis management, coordination, monitoring and implementation. He has information about key personnel involved in disaster management at the Center, State and District Level.

District/PHC Level

At district level, the chief medical officer/Civil Surgeon is responsible to implement and coordinate health sector activities. He has details of information about officers involved in disaster management at state, district and PHC level.

Non-governmental Organizations

There are a number of NGOs which are functioning in the field of disaster management. Most of them are small and work locally. However, Indian Red Cross Society and Ramakrishna Mission are the two organizations, which take very active part in disaster management. As a matter of fact, these two organizations supplement government efforts. They have sufficient infrastructure to provide immediate facilities within shortest possible time. Details of the role played by Indian Red Cross in disaster management are given below.

Indian Red Cross Society

Besides its activities related to mother and child welfare, including nutrition program, arrangements of relief to the victims of epidemics, earthquakes, cyclones, droughts, floods and natural and industrial calamities is also a function of the Red Cross. They also provide paramedical education in fields like first aid, nursing and blood banking. Promotion of voluntary blood donation is an important activity of the society. There is a network of 51 blood banks run by Red Cross in 11 states. Medical relief is extended to the community through their static and mobile units.

International Day for Disaster Reduction: 14th October

This day is dedicated to strengthening of pre-disaster prevention, preparedness and steps for mitigation measures and prompt and efficient response, National Disaster Management Authority (NDMA) has strived to train the community to face challenges of both natural and man-made disasters.

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